THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1921

Vol. XLVI.

WITH FORTY-SIX PLATES

And 188 Text-figures.

SYDNEY:

PRINTED AND PUBLISHED FOR THE SOCIETY BY

THE SYDNEY AND MELBOURNE PUBLISHING CO., LTD.,

29 Alberta Street, Sydney.

AND

SOLD BY THE SOCIETY.

1921.

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(Issued 1st June, 1921.)

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(Issued 12th August, 1921).

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(Issued 2nd November, 1921.)

PART IV. (No. 184).

(Issued 23rd December, 1921.)

LIST OF NEW FAMILY, SUBFAMILY AND GENERIC NAMES PROPOSED IN THIS VOLUME (1921).

CORRIGENDA.

Page 257, In table of analyses transpose the words "Lime as oxalate" and "Total lime."

Page 327, lines 34-35, for *F. Schottiana* var. *grandis*, read *F. pubescens*.

Page 328, line 5, *for* 730, *read* 73.
line 24, *for* Mr., *read* Mrs.
line 43 (5th from bottom), *delete* "Austr."
line 47, *for* Mrs. *read* Miss.

Page 331, line 21, *for* size large, *read* size larger.

Page 332, line 8, for *Cicindela*, read *Cicindelae*.
line 20, *for* Cart., *read* Cast.

LIST OF PLATES.

PROCEEDINGS, 1921.

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES.

Wednesday, 30th March, 1921.

The Forty-sixth Annual General Meeting, together with the Ordinary Monthly Meeting, was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, 30th March, 1921.

ANNUAL GENERAL MEETING.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

The Minutes of the preceding Annual General Meeting (31st March, 1920) were read and confirmed.

PRESIDENTIAL ADDRESS.

During the past year there have been a number of events of more than usual interest to those who follow the trend of progress in scientific affairs. The more important of these include (1) the placing of the Australian National Research Council on a permanent footing, (2) the permanent establishment of the Commonwealth Institute of Science and Industry, (3) the first Pan-Pacific Scientific Conference, and (4) the renewal of the regular meetings of the Australasian Association for the Advancement of Science.

To the close observer these events have special significance, indicating as they do an increased tendency for sympathetic international co-operation in scientific affairs, and also reflecting, in Australia, the almost world-wide attempts that are being made to bring about closer and more sympathetic relations between Science and Industry than have existed in the past.

Last year I drew your attention to the preliminary steps that had been taken towards the formation of an Australian National Research Council to work

in conjunction with the International Research Council. A provisional Council had been nominated, with a small executive, to hold office until the meeting of the Australasian Association for the Advancement of Science in January last. At this meeting the necessary steps were taken to place the Research Council on a permanent footing, and the following resolutions were agreed to:—

1. The Resolutions of the Conference held in Sydney on 21st August, 1919, shall cease to be operative from this day, 15th Jan. 1921.
2. The National Research Council shall consist of not more than 100 members and shall contain two or more representatives of each of the following branches of Science and of such others as may be determined from time to time by the General Council of the Australasian Association for the Advancement of Science. [List of Branches as in Resolution 3, with addition of Economics and Statistics and of Mental Science and Education. It was also decided to add a Section of Mining and Metallurgy (with Messrs. R. C. Sticht and G. C. Klug as representatives)].
3. The members of the provisional Council are hereby elected members of the Research Council, together with Mr. G. H. Knibbs and Mr. G. Lightfoot (representing Economics and Statistics), and Professor Laby.
4. The members as defined in Clause 3 shall co-opt additional members within the numerical limit prescribed in rule 2, and shall select such additional members in consultation with the Presidents of the more important Scientific, Technical and learned Associations and Societies of the Commonwealth.
5. The Council may appoint as Associate members, scientific workers resident in Australia who are deemed likely to confer benefit by their researches.
6. The Council may appoint such standing Committees and Special Committees as it deems requisite for national or inter-national purposes.
7. The Council may appoint such office-bearers as it may determine. These shall hold office for a term of two years and be re-eligible.
8. A meeting of the members as defined in Clause 3, shall be held at Sydney, not later than May, 1921, for the purposes indicated in rule 4, and a meeting of the whole Council so constituted shall meet as soon as possible thereafter for the purposes indicated in rules 5, 6, 7 and for the formulation of by-laws and any other necessary business.
9. Members unable to attend any such meeting may communicate their views beforehand in writing to the Hon. Sec. and all such communications shall receive full consideration at the meeting.
10. Every member and Associate member shall retain his membership for life unless it be terminated (1) by his resignation, (2) by his ceasing to reside in Australia, (3) by vote of at least two-thirds of the members.
11. The Council shall submit a full report of its work and proceedings to the Australasian Association for the Advancement of Science on the occasion of each meeting of the Association.
12. Until other arrangements are made for the financial support of the Council, each member thereof shall be liable to contribute the sum of £2 2s. per annum, and each Associate member £1 1s. per annum.
13. That the Provisional Executive Committee be asked to continue to act *pro tem.* till the Council has appointed its office-bearers.

Supplementary.

a. Resolution 3 of 21st August, 1919, reads as follows:—

"That the branches of science to be represented include:—Agriculture, Anthropology, Astronomy, Botany, Chemistry, Engineering, Geography, Geology, Mathematics, Meteorology, Pathology, Physics, Physiology, Veterinary Science, Zoology."

b. The provisional executive committee appointed at the same time is as follows:—Professor Sir Edgeworth David, K.B.E., D.S.O., D.Sc., F.R.S. (Chairman), Mr. R. H. Cambage, F.L.S. (Honorary Secretary), Professor H. G. Chapman, M.D., Mr. J. H. Maiden, F.R.S., Professor J. A. Pollock, D.Sc., F.R.S.

The Bill for the establishment of the Commonwealth Institute of Science and Industry has, after much delay, become law, and the Institute is now on a permanent footing. Unfortunately, the general necessity for economy has resulted in a considerable curtailment, both as regards funds and personnel, compared with the intentions of some two or three years ago. The present functions and scheme of working of the Institute may perhaps be best expressed by the following two sections of the Bill:—

5. The Institute shall establish (*a*) a Bureau of Agriculture; (*b*) a Bureau of Industries; and (*c*) such other bureaux as the Governor-General determines.

6. The Governor-General may appoint a General Advisory Council and Advisory Boards in each State to advise the Director with regard to (*a*) the general business of the Institute or any bureau thereof; and (*b*) any particular matter of investigation or research.

The scope for such an Institute is unlimited; a high standard has been set by the Advisory Council, a temporary body which has carried on the work for some years past, and in wishing the permanent Institute success, we can only hope that this standard may be maintained or perhaps even surpassed.

An event of considerable importance to science in Australia was the first Pan-Pacific Scientific Conference, held in Honolulu in August, 1920. This Conference was convened by the Pan-Pacific Union, the general idea being to stimulate the consideration of scientific problems connected with the Pacific Ocean and the countries bordering it. With this object, invitations were issued to scientific workers and scientific institutions in countries bordering the Pacific, and as a result some 110 delegates attended the first Conference, including representatives from the Hawaiian Islands, Canada, United States of America, Australia, New Zealand, Philippine Islands, China and Japan. Apart from the discussion of scientific problems, preliminary steps were taken to set up a permanent organisation designed for the advancement of the common interests of the Pacific, including scientific research. Pending the establishment of this permanent body, a provisional Council was elected consisting of one representative from each of the countries mentioned above except China. The Australian representative on this Council is Mr. E. C. Andrews, Government Geologist of New South Wales.

This organisation paves the way for helpful co-operation between Institutions and Governments in the various countries bordering the Pacific in working our common problems; should it succeed in becoming permanently established we may expect great advances towards the elucidation of the many scientific problems so intimately associated with the Pacific Ocean and its borders.

It is proposed to hold triennial meetings, and there is a possibility of the next meeting being held in Wellington, N.Z. Australia had six representatives at the Honolulu meeting, four of them—Dr. L. A. Cotton, Messrs. E. C. Andrews, C. Hedley and C. A. Sussmilch—being Members of this Society, the other two being Professors F. Wood-Jones, of Adelaide, and H. C. Richards, of Brisbane.

The fifteenth meeting of the Australasian Association for the Advancement of Science, the first since 1913—no meeting having been held during the War—was to have been held in Hobart in January. As a result of the dislocation of shipping by strikes, a change of plans became necessary at the last minute, and the meeting was held in Melbourne. Despite the short notice and the unfavourable conditions resulting from the strike the meeting was a highly successful one.

Many important and interesting discussions took place both on the papers presented and on special subjects. One very urgent matter brought forward, a subject in which this Society is especially interested, was the need for some organisation to provide for the systematic working out of our fauna and flora, more particularly those sections of it which are being rapidly exterminated. The Biology Section recommended the formation of an Inter-State Committee composed of representatives of all the various Societies concerned with the study of natural history and the preservation of our flora and fauna, whose duty it would be to organise, each in its own State or locality, the carrying out of special investigations. Sir Baldwin Spencer has further called attention to the urgency of this subject in the Victorian Naturalist for February, 1921, pp. 120-122. Referring more particularly to the land and fresh-water fauna, he says (pp. 120-1): —"Settlement and bush-fires are interfering disastrously with the land and fresh-water fauna, and yet it is perhaps the most interesting in any part of the world. Important as is the study of the marine fauna, we must, from a scientific point of view, realize very clearly the fact that this will ever be with us, and we can investigate it at our leisure; but the land and fresh-water fauna is disappearing rapidly, and unless we now make an organised effort it will be too late to study it effectually, and future generations will wonder what manner of people we were not to leave behind us some adequate record of the marvellously interesting forms of animal life which we had succeeded in exterminating."

We cannot but admit the seriousness of the position from the scientific point of view, and it behoves us, not only as a Society, but as individuals interested in Natural History, to do all in our power to assist such a movement as that proposed.

The magnificent bequest of the late Sir Samuel McCaughey to the University of Sydney has allowed, amongst other things, the establishment of a number of additional Chairs and Lectureships. Of these we are particularly interested in the appointment of an Associate Professor of Geography and of a Lecturer in Entomology. Geography is one of the subjects in which a Linnean Macleay Fellowship may be awarded, and there is little doubt that under the guidance of Professor Griffith Taylor, himself a man of distinguished researches in his subject, there will spring up a school of students eager for the opportunity of conducting research in this rather neglected branch of science in Australia. Our little band of enthusiastic workers in Entomology has accomplished work of a high standard in the past, but with the field so wide and the workers so few the difficulties have been great. We therefore heartily welcome the prospect of an opportunity being provided by which students may obtain a systematic training in the subject, and look forward to notable developments in this very important

branch, not only on its purely scientific side, but also in its economic application.

The Special Meeting held on 14th June last in Commemoration of the centenary of the birth of Sir William Macleay, the Society's benefactor, was a very successful function. As one of the results we have now on record (in Part iv. of the Proceedings for 1920) a detailed historical record of the Society's interest in Alexander, William Sharp, and George Macleay.

The Society's Honour Roll was unveiled at the above meeting by Professor Wilson, and now hangs in the Hall as a permanent record of the names of those Members of the Society who served the Nation abroad during the Great War. The Roll is the work of Mr. Hardy Wilson, who has furnished the following explanation of the design:—

"I have used Roman lettering surrounded by the Roman roll and bead; the whole design contained within an adaptation of the Roman egg and dart ornament.

In the coloured border are introduced ancient Chinese symbols. At the corners are endless knots which signify eternal or everlasting. From the knots depend strings of Bay leaves, symbols of honour. At the centre of each side is a very ancient Chinese sign, representing Victory. Thus the border may be read:—

Everlasting Honour for their Victory.

Adjoining are conventionalised bats. The bat is a favourite device in old Chinese Art, and signifies happiness. At the angles is a peach, another old sign, for longevity. This margin, then, may be read:—

Wishing them long life and happiness."

A coloured reproduction of the Roll accompanies Part iv. of the Proceedings for 1920 as a frontispiece.

On the occasion of the visit of H.R.H. the Prince of Wales to Sydney in June last the Council decided to present to His Royal Highness an address of loyalty and welcome on behalf of the Members of the Society. The text of the address, as officially approved, was as follows:—

"We, the Members of the Linnean Society of New South Wales—a Society founded in 1874 to develop the study of the Natural History of Australia, as its great English prototype, the Linnean Society of London, has done to encourage that of the Natural History of the British Isles—desire to be allowed to offer to Your Royal Highness, with all due respect, this brief record of our loyalty to the Throne, of the pleasure evoked by the visit of Your Royal Highness as the representative of our revered Sovereign, and our respectful greetings and sincere wishes for an enjoyable and fructifying visit, and for the welfare of Your Royal Highness."

The concluding Part of Volume xlv. of the Society's Proceedings was issued on 7th March. The complete volume (653 and xxi. pp., 32 Plates, and 138 Text-figures) contains thirty-two papers, nine of which were contributed by members of the Society's research staff. This completes the first volume in the new size, and the result of the change in size may be considered wholly satisfactory.

The greatly increased cost of scientific publications has been the cause of much worry to Councils of scientific Societies the world over (*see* Nature, 6th May, 1920, p. 285), and in very many cases it has been found necessary to greatly restrict publication or to raise subscriptions. We are indeed fortunate, and we should acknowledge our debt in this respect to our Benefactor, Sir William Macleay, in having been able to carry on with only very little restriction in the amount of printing. The issue of the Monthly Abstract of Proceedings was

discontinued from July, 1916, to October, 1919, but the Proceedings have been issued uninterruptedly, and have suffered no reduction in volume.

One of the most serious consequences to the scientific community of this increase in the cost of publishing was the possibility of the discontinuance of the publication of the International Catalogue of Scientific Literature. An international conference, convened by the Royal Society of London, met to consider this matter last year. They came to the conclusion that, "even though a change be made in the future in the method of indexing, it is imperative to continue the International Catalogue of Scientific Literature in its present form until the literature published up to the end of the year 1915, and possibly also that up to the end of the present year 1920, has been catalogued. In this way the important scientific work carried out during the War period will become available for reference at an early date and continuity in the work of indexing be maintained." (Nature, October 7, 1920, p. 195). This recommendation was to be placed before the Council of the Royal Society for consideration.

In the meantime efforts have been made to obtain additional subscribers to the Catalogue, and also to ascertain whether former purchasers would continue at the increased charges necessitated by the increased costs. It is the earnest hope of all concerned that the Royal Society may see its way clear to continue the issue of this invaluable publication.

The question of the issue of the Catalogue for papers published after 1920 was referred to a committee of the delegates at the Royal Society's conference for further consideration.

Exchange-relations with Societies and Institutions show a more decided return this year towards normal. The receipts for the Session amounted to 1603 additions to the library, being more than for the years immediately preceding the War. This is, of course, due to the receipt of publications issued during the War by many Societies, etc., who were unable to despatch their volumes to us as they were issued. In addition to the Belgian Societies to which I made special reference last year, we have resumed exchange-relations with Societies in countries which have been cut off for exchange purposes for some years—these include Norway, Sweden, Finland, France, Holland, Hungary and Austria—and we have also resumed exchanges with one German institution.

During the year the following additions have been made to the list of journals obtained in exchange for the Society's Proceedings:—American Journal of Botany, Annals of the Durban Museum, Bulletin of the Public Museum of the City of Milwaukee, Journal of the Arnold Arboretum of Harvard University, Journal of Experimental Zoology, Journal of Morphology, Natural History (from the American Museum of Natural History), Trabajos del Museo Nacional de Ciencias Naturales (Madrid).

The scientific portion of the library of the late F. M. Clements, bequeathed by him to the Society, formed a very valuable addition to the library, more particularly to the ornithological section. In addition to a number of small books on electricity and a few medical works, this bequest included the following volumes:—Ball, Sir Robert, The Story of the Heavens (1905); Bentley, R., A Manual of Botany (1887); Blakston, W. A., Swaysland, W., and Wiener, A. F., The Book of Canaries and Cage Birds; Bonhote, J. L., Birds of Britain (1907); Broinowski, Gracius J., Birds of Australia, Vols i.-vi., (1890-1891); Buller, Sir W. L., Birds of New Zealand, Vols. i.-ii. (1888); Collinge, W. E., The Food of Some British Wild Birds; A Study in Economic Ornithology (1913); Department

of Mines, N.S.W., Palaeontology No. 4. The Fossil Fishes of the Hawkesbury Series at Gosford. By A. S. Woodward, F.Z.S., F.G.S. (1890); Des Murs, O., Iconographie Ornithologique, Pt. i, (1849); Dewar, Douglas, Indian Birds (1910); Dixson, Charles, The Bird-Life of London (1909); Duncan, F. M., Our Insect Friends and Foes (1911); Fabre, J. H., The Life and Love of the Insect (1914); Favenc, Ernest, The History of Australian Exploration (1888); Forbes, George, History of Astronomy (1909); Froggatt, Gladys H., The World of Little Lives (1916); Fyfe, H. H., South Africa To-day (1911); Gale, Albert, Australian Bee Lore and Bee Culture (1912); Aquarian Nature Studies (1915); Gosse, P. H., Illustrations of the Birds of Jamaica (1849); The Birds of Jamaica (1847); Gould, J., Monograph of the Trochilidae, Vols. i.-v. (1861); Handbook to the Birds of Australia, Vols. i.-ii. (1865); Gray, G. R., Hand-list of Genera and Species of Birds, Pts. i.-iii. (1869-1871); The Genera of Birds, Vols. i.-iii. (1844-1849); Green, J., Ocean Birds (1887); Greene, W. T., Parrots in Captivity, Vols. i.-iii. (1884-1887); Haddon, A. C., History of Anthropology (1910); Harmsworth Popular Science, Vols. i.-vii.; Haeckel, Ernest, The Evolution of Man, Vols. i.-ii. (1910); Haeckel, Ernest, and Lankester, E. R., The History of Creation, Vols. i.-ii. (1883); Hopkins, G. M., Experimental Science, Vols. i.-ii. (1902); Johnston, Sir Harry, Liberia, Vols. i.-ii. (1906); Knox, A. E., Ornithological Rambles in Sussex (1850); Game Birds and Wild Fowl; Their Friends and Their Foes (1850); Layard, E. L., and Sharpe, R. B., The Birds of South Africa (1884); Leach, J. A., An Australian Bird Book (1916); Legge, Capt. W. V., Birds of Ceylon, Vols. i.-ii. (1880); Lloyd, L., The Game Birds and Wild Fowl of Sweden and Norway (1867); Lucas, A. H. S., and Le Souef, W. H. D., The Animals of Australia (1909); The Birds of Australia (1911); Lyell, Charles, Principles of Geology, Vols. i.-iii. (1840); Marriner, G. R., The Kea: A New Zealand Problem (1908); Mathews, G. M., A List of the Birds of Australia (1913); Morris, B. R., British Game Birds and Wild Fowl (1891); Morris, Rev. F. O., A History of British Birds, Vols. i.-vi. (1895-1897); Morris, Rev. F. O., and Tegetmeier, W. B., Nests and Eggs of British Birds, Vols. i.-iii. (1896); Mueller, Baron F. von, Eucalyptographia (1884); Osborn, H. F., Men of the Old Stone Age (1918); Parker, T. J., and Haswell, W. A., A Text-Book of Zoology, Vols. i.-ii. (1910); Pescott, E. E., The Native Flowers of Victoria; Proceedings of the Zoological Society of London, 1918, Pts. iii.-iv. (1919); Randall-Maciver, D., Mediaeval Rhodesia (1906); Roughley, T. C., Fishes of Australia and their Technology (1916); Sclater, P. L., A Monograph of the Jacamars and Puff Birds (1879-1882); Selous, F. C., African Nature Notes and Reminiscences (1908); Shelley, Capt. G. E., Sun-Birds (1876-1880); Smith, R. B., Bird Life and Bird Lore (1909); Sulman, Florence, The Wildflowers of N.S.W., Vol. ii. (1914); Swainson, W., A Selection of the Birds of Brazil and Mexico (1841); Thomas, H. H., The Rose Book (1913); Thompson, W., The Natural History of Ireland, Vols. i.-iii. (1849-1851); Thorington, J., Refraction and How to Refract (1911); Thorpe, Sir Edward, History of Chemistry, Vols. i.-ii. (1909-1910); Turner, Fred, Australian Grasses, Vol. i. (1895); Weber, C. O., The Chemistry of India Rubber (1903); Wood, Rev. J. G., Insects at Home (1883); Wonderful Nests (1887); Woodward, H. B., History of Geology (1911); Yarrell, William, A History of British Birds, Vols. i.-iii. (1843).

The Society has also received during the year copies of Botanical Magazine (16 vols.) and "Histoire Naturelle" (3 vols., published 1750), bequeathed to it by the late E. R. Deas Thomson.

During the year sixteen Ordinary Members were elected, two resigned, and one died. In addition, three names have been removed from the list, and news has been received of the decease of one of our members in England. The number of Ordinary Members now on the roll is 159.

Frederick Moore Clements, an Englishman by birth, died at Stanmore on 19th August, 1920, at the age of 63 years. He spent the early part of his life in Birmingham, where he served his apprenticeship to a chemist. After spending about a year in South Africa, he came to Sydney towards the end of 1881. He was elected a member of the Pharmaceutical Society of New South Wales in 1884, and of the Pharmaceutical Society of Australasia in 1891. Mr. Clements was a man who attained considerable eminence in his profession, being perhaps best known for his manufacture of Clements' Tonic for which purpose he erected a large factory at Enmore, selling a greater part of his interest to a company in 1906. He made a special study of and took great interest in the application of electricity in his profession. Apart from his profession he was a man of many hobbies, amongst which were included a very keen interest in both botany and ornithology. He was elected a Fellow of the Zoological Society of London (1910), of the Linnean Society of London (1917), and of the Royal Geographical Society of London (1919), and a member of this Society in 1911. His great interest in botany and ornithology is shown by the many rare plants in his fine garden at Stanmore and by his aviary, as well as being reflected in his library.

Although we never had the privilege of seeing him at our meetings, we know that he took some interest in the Society by reason of his having bequeathed to it the scientific portion of his library and two pictures. This magnificent bequest consists of over one hundred volumes on natural science, a list of which is given above (pp. 6, 7), in addition to a large number of medical and electrical works.

His broad human sympathies are indicated by the wide scope of his bequests to charitable and other institutions, among which may be noted Dr. Barnardo's Homes, The Ragged School Union, The National Institute for the Blind, and The Royal Humane Society.

Thomas de Gray, sixth Baron Walsingham, who became a member of this Society in 1892, died on 3rd December, 1919. He was the greatest authority on the Microlepidoptera of the World, and we take the following summary from Entomological News (May, 1920, xxxi., No. 5):—He was born in Mayfair, London, July 29, 1843, went to Eton in 1856, and to Trinity College, Cambridge, in 1860. The University made him B.A. in 1865, M.A. in 1870, and High Steward and LL.D in 1891. He was a member of the House of Commons for West Norfolk, 1865-1870, succeeding to the title and estates of his father in the latter year. He was appointed a Trustee of the British Museum in 1876, and to it he gave his entomological library and collections in 1910. These consisted very largely of Lepidoptera, both imagines and larvae, especially of the Microdepidoptera.

He was elected a Fellow of the Royal Society in 1887, and was President of the Entomological Society of London, 1889-90.

The Rev. W. W. Watts was born on 5th October, 1856, near Ivybridge, Devonshire, England. He was a student at New College, London, for six years, preparing for the Congregational ministry. He was ordained and held a charge at Stratford-on-Avon, but, ill-health having supervened, he came to Australia and settled at Milton, Queensland. The floods of 1893 destroyed both church and house, and he went to New Zealand, where he began his first studies on ferns and mosses. He was resident in New South Wales for many years, and, having be-

come a Presbyterian Minister, he received a charge in the Richmond River district, where he had great facilities for his special botanical studies. Later, he settled in the Sydney district, at Gladesville, and was Honorary Custodian of Ferns and Mosses in the National Herbarium from 1909 till 1916, when he left for Melbourne. He was liberal in his contributions to the National Herbarium, and after his death, which took place at Canterbury, Victoria, on 20th September, 1920, his collection of ferns and mosses, which contained a large number of types, was purchased for that institution.

He was a member of this Society from 1912 to 1919, and contributed 14 papers, in addition to 5 joint papers, during the years 1899 to 1918. The majority of these dealt with Australian Mosses and Hepatics, adding considerably to our knowledge of these groups in Australia. I am indebted to Mr. J. H. Maiden for very kindly supplying much of the above information.

Two more of our older Members, Messrs. A. A. Hamilton and H. G. Smith, have joined those who have retired from their official duties. Mr. Hamilton has for a number of years been Botanical Assistant at the Botanic Gardens, and has taken especial interest in the ecological side of botanical work. Mr. Smith has been associated with Mr. R. T. Baker at the Technological Museum, where their joint researches, such as those on the Eucalypts and Pines of Australia, have commanded worldwide notice, and have done much to foster the development of the economic possibilities of portions of the Australian flora.

To Mr. R. T. Baker, who has recently been honoured by the award of the Mueller Memorial Medal by the Australasian Association for the Advancement of Science, I would offer on behalf of Members, very cordial congratulations. Mr. Baker's work is well known to us, and it is particularly appropriate that his botanical researches should be recognised by this award which commemorates the work of one of the most distinguished Australian Botanists. Previous recipients of the medal include A. W. Howitt (1904), J. P. Hill (1907), T. W. Edgeworth David (1909), R. Etheridge, Jr. (1911), and W. Howchin (1913), three of them having been Members of this Society.

To the following Members we offer our cordial congratulations and good wishes:—Dr. Robert Broom, a Corresponding Member, on his election as a Fellow of the Royal Society; Sir Edgeworth David and Mr. J. H. Campbell on the honour conferred on them by His Majesty the King in their inclusion in the list of recipients of Honours of the British Empire Order; Professor J. T. Wilson, on his appointment as Regius Professor of Anatomy in the University of Cambridge; Professor H. G. Chapman, on his appointment as Professor of Physiology in the University of Sydney in succession to the late Professor Anderson Stuart; Mr. A. H. S. Lucas, on his appointment as Headmaster of the Sydney Grammar School; Dr. E. W. Ferguson, who has been appointed Principal Microbiologist in succession to Professor J. B. Cleland; Dr. H. Priestly, on his appointment as Associate Professor of Physiology in the University of Sydney; Dr. C. Anderson, on his selection for the important position of Director of the Australian Museum; and Mr. C. Hedley, on his appointment as Principal Keeper of the Zoological Collections in the same Institution.

The year's work of the Society's research staff may be summarised thus:

Dr. R. Greig-Smith, Macleay Bacteriologist to the Society, contributed one paper, "Ropiness in Wattle Bark Infusions," which appeared in Part i. of the Proceedings for 1920. A further examination was made of the bacteria contained in nodules at the base of Eucalyptus seedlings; a varied flora was obtained

from these nodules, including some organisms which may possibly be the *B. tumefaciens* of Erwin F. Smith, or perhaps the Rhizobium of the Leguminosae, and others that differ in liquefying gelatine. As far as the examination was carried each nodule appeared to have a flora of its own. Infection experiments with the bacteria so obtained gave entirely negative results. An investigation into the fermentation of the tan-bark used in connection with the corrosion of white lead resulted in the discovery of bacteria which grow actively at 60° C.; and some proof was obtained of the fermentation by this high temperature organism which also ferments sugar under certain conditions. The results obtained to date form the subject of a paper which is ready for publication. A short note has also been prepared on "the extraction of acids from cultures" being the outcome of an unsuccessful attempt to obtain tartaric acid from the fermentation of sugar. Attempts were also made, but without success to obtain a glucoside from the activity of wattle-bark bacteria, and to obtain eugenol from leaves of Melaleuca containing methyl-eugenol, by yeast fermentation.

The Council has granted Dr. Greig-Smith leave of absence during 1921 for the purpose of visiting Europe and getting into touch with the more prominent workers in the bacteriological laboratories there.

Dr. J. M. Petrie, Linnean Macleay Fellow of the Society in Biochemistry, completed his chemical examination of the leaves of *Macrozamia spiralis*, the results appearing in Part iii. of the Proceedings for 1920; he was unable in this investigation to identify any of the chemical constituents with the symptoms of poisoning observed in long-continued feeding of animals with the leaves. The general investigation of Cyanogenesis in Plants was continued, Part iv. "The Hydrocyanic Acid of *Heterodendron oleaefolia*—A Fodder Plant of New South Wales," appearing in Part iii. of the year's Proceedings. Future work in this subject has for its object the determination of the factors concerned with the storage of cyanogenetic glucosides as reserve food-material and the conditions under which these may become poisonous. The leaves of the poisonous plant, *Erythrophloeum* from Darwin have been investigated, and a very small quantity of an alkaloid obtained from them. The alkaloid is a most powerful poison, and an attempt is being made to ascertain its definite pharmacological action on animals. During the early part of the year Dr. Petrie's work was unfortunately interrupted by a severe attack of pneumonia and chronic bronchitis which took some months to pass off.

Miss Vera Irwin Smith, Linnean Macleay Fellow of the Society in Zoology has continued her studies of Nematodes and of the life-histories of Brachycerous Diptera. The family Stratiomyiidae is being dealt with first, being of special interest because of the peculiar intermediate position it occupies between the Orthorrhapha and Cyclorrhapha. The first results of this study have been embodied in a paper on the life-history of *Metoponia rubriceps*, which appeared in Part iv. of the Proceedings for 1920. A second paper, dealing with the mouth parts of the same insect, is in course of preparation. Attempts are also being made to breed it through from the egg. The families Mydaidae, Therevidae and Asilidae are also under observation, many larvae having been collected and bred through to various stages. Miss Smith's studies of the Nematodes have resulted in the completion of one paper, "The Nematode Parasites of the Domestic Pigeon in Australia," which also appeared in Part iv. of the year's Proceedings. It is her intention to continue these studies and deal in the same way with the parasites of the goat, chicken and lizard in Australia.

Miss Marjorie I. Collins, Linnean Macleay Fellow of the Society in Botany, has contributed two papers to the Proceedings during the year—"Note on Certain Variations of the Sporocyst in a species of Saprolegnia," and "On the Structure of the Resin-Secreting Glands in some Australian Plants," the observations for both papers having been made while she was demonstrating in Botany in the University of Adelaide.

Miss Collins has continued her observations on the secretion of resin in the bud of some Australian plants and the resultant phenomenon of "leaf-lacquering," common in xerophytic floras. At the same time she has also devoted some of her time to an ecological study of the mangrove and saltmarsh vegetation at Cabbage Tree Creek, Port Hacking. The encroachment of certain plant associations upon the partially drained salt-marsh has been observed, and samples of the soil collected from suitable places on the mangrove and salt-marsh areas have been investigated. In continuation of this side of her work, Miss Collins proposes to select another area for detailed ecological study, preferably a region with low annual rainfall.

Six applications for Linnean Macleay Fellowships, 1921-22, were received in response to the Council's invitation of 27th October, 1920. I have now the pleasure of making the first public announcement of the Council's re-appointment for another year from 1st April, 1921, of Dr. J. M. Petrie, Miss V. Irwin Smith and Miss Marjorie I. Collins to Fellowships in Biochemistry, Zoology, and Botany respectively; and of the appointment for one year of Miss Marguerite Henry, B.Sc., to a Fellowship in Zoology from 1st proximo. On behalf of the Society I have much pleasure in wishing them a very successful year's research.

Miss Henry has already had sufficient experience of research work to justify our expectation that her proposed research on the Freshwater Entomostraca of Australia and New Zealand, with special reference to their ecological distribution will form a worthy addition to the growing volume of work accomplished by the Linnean Macleay Fellows.

Miss Henry graduated in Science at the University of Sydney in 1917 with second class Honours in both Zoology and Botany. The same year she was appointed assistant-zoologist to the Committee of the Commonwealth Advisory Council of Science and Industry for the investigation of worm nodules in cattle, and has since been continuously engaged on this work. This investigation into the life-history of the parasitic Nematode (*Onchocerca gibsoni*) has involved a wide search for the intermediary host, in the course of which especial attention has been paid to the Tabanidae and freshwater crustacea. As a result, apart from the routine work involved, she has published three original papers, two of them, "On some Australian Cladocera," and "On some Australian Freshwater Copepoda and Ostracoda," in the Journal and Proceedings of the Royal Society of N.S.W., and one (in collaboration with Dr. E. W. Ferguson), "Tabanidae from Camden Haven District, N.S.W." in Part iv. of our Proceedings for 1919.

Dr. Walkom's duties as Secretary have allowed him some time to continue his researches on Australian Fossil Plants, and during the year he has completed an account of the Jurassic Plants from Talbragar, N.S.W., which has just appeared as a memoir of the Geological Survey of N.S.W. He has also almost completed the examination of the Glossopteris Flora of Queensland, in the course of which he has discovered an extremely interesting association of seeds with leaves of Glossopteris. The association appears to be sufficiently close to warrant the assertion that the seeds are those of a species of Glossopteris, and should this be

borne out, the discovery will be one of considerable interest and importance in Palaeobotany; for this reason, a short account of it has been prepared and forwarded for publication in England. A description of some Jurassic Plants from Western Australia, together with some notes on the occurrence of Otozamites in Australia has been completed and will appear in the coming year's Proceedings.

Is All Well with the Macleay Museum of the University of Sydney?

Sir William Macleay's scientific energy was directed into two main channels; and his efforts finally culminated in two important potentially fructifying enterprises. On the one hand, with the generous assistance of the Government, a duly constituted Macleay Museum. On the other hand, the Linnean Society of New South Wales, endowed not only for the ordinary purposes of a Scientific Society, but in an especial manner for the encouragement of research-work in Natural History. In his own characteristic way, Sir William linked up these two great enterprises in such a way, that each of the two corporate bodies to whom these enterprises were committed upon trust, in perpetuity, should have a *locus standi* for a co-ordinate, reciprocal interest in what the other was doing with his Trust.

Ever since it has been possible, the Linnean Society has given, in print, an annual report of its stewardship, and has distributed the same to all entitled to receive it. Where are the University's annual reports of its stewardship in connection with the Macleay Museum?

In 1873, Sir William offered the amalgamated collections of Alexander Macleay, W. S. Macleay, and his own, together with his scientific library, as a gift by bequest, upon trust, to the University, for the promotion of natural history, and the instruction of students, and the inhabitants of the colony in the same. The sum of £6000 was offered at the same time for the endowment of a Curatorship. At this time, the joint-collections of A. and W. S. Macleay amounted to 480 drawers of insects and other Annulosa, and W. Macleay's own collection to 320 drawers of insects. At this time Sir William had not appointed a Curator. The Senate gratefully accepted the offer. The Chancellor announced the offer, and its acceptance by the Senate, at the Commemoration in March, 1874. At this time too, the Linnean Society of New South Wales had not been so much as thought of, nor was its establishment anticipated.

After the offer had been made and accepted, but before the public announcement was made, Sir William decided to appoint a Curator, Mr. George Masters, and decided to convert his own entomological collection into a general collection, not only of Australian, but also of non-Australian Vertebrata, and Invertebrata; and for fifteen years, with the co-operation of Masters, he continued to carry out this intention. Why did he do this? To make the gift more worthy of acceptance by the University.

In 1885 or 1886, Sir William changed his mind about leaving his scientific library and the Macleay Collections as a bequest to the University. He withdrew his offer of the library altogether, and re-offered the now much enlarged Macleay Collections as a gift during his life-time, if and as soon as a "suitable" building —not a room in a building—was provided for them. For two reasons, because his own collection had been so enlarged, that his private museum was overcrowded, and that he naturally wished to have an opportunity of approving of the suitability of the "suitable" building offered. He also offered to transfer his experienced Curator, and an endowment-fund of £6000 to provide the Curator's salary.

The Senate, not having the money, approached the Government, and asked for its help to enable it to accept Mr. Macleay's munificent gift. The Government, knowing William Macleay, asked what he would approve of as a suitable building. His reply was, that he would approve of a fire-proof hall, 212 × 70 × 58 feet, with bays and a gallery all round, the architect's estimated cost of it being £16,000. The Government said the equivalent of, Certainly, you shall have it, go ahead forthwith!

When the building was finished in about 1889 [exact date not available], and approved of by Sir William, he transferred the amalgamated Collections, now a general collection, and not merely a collection of insects and other Annulosa to the University, to be housed in the "suitable" building, presented by the Government, together with his experienced and faithful Curator, George Masters; and paid over the sum of £6000, for the endowment of the Curator's salary. When the Collections had been suitably arranged, under the direction of the Professor of Biology with the co-operation of the Curator, as an exposition of the fauna of Australia, for which there was abundant material in the Collection, the Macleay Museum of the University of Sydney was duly constituted, in the technical sense. Thereupon, the University, *ipso facto*, became the Joint-Trustee of the Government and of Sir William Macleay, for the inhabitants of New South Wales, including students and others. The Joint-Trustee's duties were to administer the Trust committed to him in terms of the Trust. Among other things, therefore (1) to preserve, maintain, and safeguard the standard, agreed-upon suitability of the "suitable" building, presented by the Government solely and expressly for housing the suitably arranged Macleay Collections, and any additions that might be made to them, in perpetuity; and to abstain from tampering with it, and finally, spoiling it. (2) To preserve, maintain, and safeguard, the integrity of the Macleay Collections, in perpetuity; and under all circumstances to refrain from disrupting them, in perpetuity. (3) To keep interlopers from taking up their quarters in the Macleay Museum building, whether by the front door, or by "an over-bridge" or "a bridge-corridor," in perpetuity. (4) When the Collections had been suitably arranged, to abstain from periodically disturbing them; and finally sweeping away the exposition of the Australian fauna shown in the Jubilee photograph, with the besom of ingratitude, and thereby insulting the memories of the distinguished Macleays!

The University historian values the Macleay Collections, on a money-basis as "roughly assessed at £25,000." With the building, and the endowment fund for the Curatorship, the duly constituted Macleay Museum represented a benefaction of £47,000!

To-day, and for some time past, the Macleay Museum has been *deconstituted*, and as an exposition of the fauna of Australia spoilt, because the suitability of the "suitable" building has been so drastically interfered with, that this has involved the disruption of the Macleay Collections. One of Sir William's great enterprises, potentially so fructifying if properly managed, has become bankrupt. It has been hamstrung, paralysed, shorn of its attractiveness and inspiration.

Mr. J. H. Campbell, Hon. Treasurer, presented the balance sheets for the year 1920, duly signed by the Auditor, Mr. F. H. Rayment, F.C.P.A., Incorporated Accountant; and he moved that it be received and adopted, which was carried unanimously.

No nominations of other Candidates having been received, the President declared the following elections for the ensuing Session to be duly made:—

PRESIDENT: Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S.

MEMBERS OF COUNCIL (to fill six vacancies): Messrs. R. T. Baker, F.L.S., W. W. Froggatt, F.L.S., A. G. Hamilton, C. Hedley, F.L.S., T. Steel, and G. A. Waterhouse, B.Sc., B.E., F.E.S.

AUDITOR: Mr. F. H. Rayment, F.C.P.A.

On the motion of Mr. W. W. Froggatt, a cordial vote of thanks to the retiring President was carried by acclamation.

Before vacating the Chair, the President proposed a hearty vote of thanks to the Hon. Treasurer, Mr. J. H. Campbell, for the enthusiastic and capable manner in which he managed the Society's financial affairs, which was carried by acclamation.

Linnean Society of New South Wales.

GENERAL ACCOUNT. Balance Sheet at 31st December, 1920.

LIABILITIES.

Capital: Amount received from Sir William Macleay during his lifetime	£14,000 0 0	
Further sum bequeathed by his will	6,000 0 0	
		£20,000 0 0
Contingencies Reserve		750 0 0
Loan from Bacteriology A/c.		66 19 3
		£20,816 19 3

ASSETS.

Society's Freehold		£105 0 0
Investments—		
War and Peace Loans	£6,795 0 0	
N.S.W. Treasury Bills	4,000 0 0	
Loans on Mortgage	9,900 0 0	
		20,695 0 0
Income A/c. at 31st December, 1920		6 19 3
Cash in hand		10 0 0
		£20,816 19 3

INCOME ACCOUNT, Year ended 31st December, 1920.

To Salaries, Wages, and Retired Allowances		£998 0 0
" Printing Publications	£589 14 11	
" Illustrations	158 1 2	
		747 16 1
" Rates	37 17 2	
" Insurance	15 11 2	
		53 8 4
" Postage, Advertising, and Petty Cash	78 4 11	
" Printing (Sundries) and Stationery	20 4 6	
" Audit Fee	5 5 0	
" Gas and Electricity	10 15 10	
" Maintenance Sir Wm. Macleay's Grave	1 10 0	
" Telephone	11 6 3	
" Bank Charges	1 11 8	
" Address to Prince of Wales	7 7 0	
		136 5 2
" Honour Roll	30 5 0	
Less Subscriptions	14 13 0	
		15 12 0
" Premises (Additions and Renovations)		757 12 0
" Contingencies Reserve		50 0 0
		£2,758 13 7

By Balance from 1919		£610 16 8
" Subscriptions—		
1920	£130 4 0	
Arrears	36 15 0	
In Advance	5 5 0	
		172 4 0
" Entrance Fees		17 17 0
" Interest on Investments		1,046 12 9
" Sales (including 100 copies of Proceedings purchased by Government of N.S.W.)		176 8 2
" Rent (Bacteriology A/c.)		16 0 0
" Fellowships A/c. (surplus income transferred)		711 15 9
" Balance to 1921		6 19 3
		£2,758 13 7

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A., Auditor.

8th March, 1921.

J. H. CAMPBELL, Hon. Treasurer.

Sydney, 10th February, 1921.

BACTERIOLOGY ACCOUNT.

Balance Sheet at 31st December, 1920.

LIABILITIES.			ASSETS.		
Capital: Amount bequeathed by Sir William Macleay	£12,000 0 0		Investments: War Loan		£14,000 0 0
Accumulated Income capitalised	2,000 0 0		Cash—		
		£14,000 0 0	Current A/c.	£207 9 2	
Income A/c. at 31st December, 1920		299 5 0	Savings Bank	18 16 7	
			In hand	6 0 0	
					232 5 9
			Loan to General A/c.		66 19 3
		£14,299 5 0			£14,299 5 0

INCOME ACCOUNT. Year ended 31st December, 1920.

To Salary	£500 0 0	By Balance from 1919	£366 7 0
„ Rent, Rates, and Insurance	30 12 5	„ Interest on Investments	708 16 7
„ Petty Cash and Sundries	4 15 4		
„ Gas	11 14 1		
„ Laboratory, Renovations and Additions	168 2 9		
„ Apparatus and Chemicals	15 14 0		
„ Journals	45 0 0		
„ Balance to 1921	299 5 0		
	£1,075 3 7		£1,075 3 7

Examined and found correct. Securities produced.
F. H. RAYMENT, F.C.P.A.,
Auditor.
8th March, 1921.

J. H. CAMPBELL,
Hon. Treasurer.
Sydney, 10th February, 1921.

LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.

BALANCE SHEET at 31st December, 1920.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Capital: Amount bequeathed by Sir William Macleay	£35,000	0	0	Investments—			
Surplus Income capitalised	8,900	0	0	War and Peace Loans	£17,705	0	0
Commercial Banking Coy.—2nd Peace Loan A/c.	4,500	0	0	N.S.W. Stock and Treasury Bills	2,615	0	0
				Loans on Mortgage	23,580	0	0
				Peace Bonds as per contra	4,500	0	0
	£48,400	0	0		£48,400	0	0

INCOME ACCOUNT, Year ended 31st December, 1920.

	£	s.	d.		£	s.	d.
To Salaries of Linnean Macleay Fellows	£1,200	0	0	By Interest on Investments	£2,332	12	11
„ Fellows' Subsidies	20	17	2				
„ Capital A/c.	400	0	0				
„ General A/c.	711	15	9				
	£2,332	12	11		£2,332	12	11

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A.,
Auditor.

8th March, 1921.

Sydney, 10th February, 1921.

J. H. CAMPBELL,
Hon. Treasurer.

ORDINARY MONTHLY MEETING.

30TH MARCH, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

A letter was read from Sir Edgeworth David returning thanks for congratulations on his knighthood.

The Donations and Exchanges received since the previous Monthly Meeting (24th November, 1920), amounting to 37 Vols., 531 Parts or Nos., 57 Bulletins, 25 Reports and 5 Pamphlets, etc., received from 117 Societies and Institutions and 7 private donors, were laid upon the table.

REVISION OF THE AMYCTERIDES.

PART vi. *Acantholophus.*

BY EUSTACE W. FERGUSON, M.B., CH.M.

ACANTHOLOPHUS (Macleay) Schönh.

Schönherr, Mantissa Secunda Familiae Curculionidum, 1847, p. 55.

Elongate, comparatively narrow, more ovate in female; size small to large. Head with upper surface more or less deeply concave in front, with simple or compound crests above eyes. Rostrum short and thick, excavate above, clypeal plate sunk between the ends of the outer margins. Antennae long, slender. Eyes generally ovate, sometimes round, rather finely faceted. Prothorax more or less flattened above, lateral margins strongly explanate, and tuberculate, spinose or dentate, disc marked by three transverse impressions, the median only distinct at sides; generally with a distinctly marked median longitudinal area bounded on each side by a row of tubercles. Elytra subtruncate or emarginate at base, rounded or more or less produced at apex; more or less obscurely puncto-striate, the interstices granulate, the granules often obsolete; with 3 rows of tubercles in the majority of species, situated on the third, fifth and base of seventh interstices. Ventral surface in male feebly concave over basal segments, elsewhere flat or gently transversely convex; in female whole ventral surface convex. Anterior coxae sub-contiguous; tibiae sometimes with sexual characters; posterior tarsi always more or less elongate, never very short.

Type of genus, *Curculio marshami* Kirby.

The genus *Acantholophus* was formed by Schönherr for a number of species previously placed in *Amycterus* stirps 1*a*, and of which *marshami* was the type.

The name was, however, in use by previous authors for this group of species, and Macleay was quoted as the author; so that the name originally was probably a manuscript one. Mr. Sloane informs me that it appeared in Dejean's Catalogue, 1834, as *Acantholophus*, Macleay.

The first valid use of the name seems to have been by Guérin-Méneville in the Voyage de la Coquille, II., p. 122 (183?),* and his remarks should be quoted in full:—

*The exact date of publication of the parts of Guerin's work appears doubtful, *vide infra* under *A. echinatus*.

"Genre Acantholophe, *Acantholophus*, Schon. manusc. Ce genre n'était pas encore publié quand nous avons donné cet article à l'impression, cependant M. Boisduval, chargé par M. Schoenherr de surveiller l'impression de l'ouvrage de ce savant nous a assuré qu'il était établi dans le manuscrit qui s'imprime actuellement (15 decembre 1833).

Le genre Acantholophe se rapproche beaucoup des Amycterus de Schönherr, mais ses antennes longues et greles l'en distinguent d'une manière bien nette."

These brief notes, though hardly a characterization of the genus, seem almost sufficient to validate the use of the name, provided that the identity of *A. echinatus* Guér. can be fixed. I cannot find, however, that the genus was described by Schönherr at this date, as stated by Guérin-Méneville. In Schönherr's Gen. et Spec. Curc., ii., published in 1834, which is presumably the work to which Guérin-Méneville refers, *Curculio marshami* Kirby was redescribed by Gyllenhall, who placed it in the genus *Amycterus*.

In 1835 Boisduval (Voy. de l'Astrolabe, ii., pp. 369-371) referred two species to the genus—*marshami* and *echinatus*. He did not, however, characterise the genus beyond a short note.—"Les insectes de ce genre ont pour les caractères les plus grands rapports avec les *Amycterus* de Schönherr, et pour le facies une certaine ressemblance avec les Sepidium."

Owing to the uncertainty in regard to Guérin's date of publication, it is quite possible that Boisduval's use of the name will have priority.

The question of the date of the first use of the name is of some importance as Pascoe (Journ. Linn. Soc., Zool., xii., 1873, p. 7) has pointed out that the name *Acantholophus* was utilised by Koch in 1837 for a genus of spiders, 10 years before Schönherr characterised the present genus. I hold, however, that Boisduval's use of the name for two species is sufficient to justify its adoption, even if the date of Guérin-Méneville's publication is found to be later than the date of Koch's use of the name. If Guérin Méneville antedates Boisduval, the position is made more secure.

The first species described that can be assigned to this genus was *Curculio marshami* Kirby published in Trans. Linn. Soc., xii., 1818, p. 436. Following this, two, if not more, species appear to have been described under the name of *Acantholophus echinatus* by Guérin-Méneville (Voy. de la Coquille, ii., p. 122) and Boisduval (Voy. de l'Astrolabe, ii., 1835, p. 371). A full discussion of the use of the name is given later under *A. echinatus*.

Bohemann (Schönh. Gen. Spec. Curc., vii., 1, (1843), pp. 72, 74-79) described 7 species, under the genus *Amycterus*, which were subsequently removed to *Acantholophus* when that genus was formally described by Schönherr in 1847 (Mantissa Secunda Familiae Curculionidum, p. 55). These species are *aureolus*, *bivittatus*, *dumosus*, *hypoleucus*, *hystrix*, *lateralis*, and *suturalis*.

In 1854, G. R. Waterhouse (Trans. Ent. Soc., iii., part 2) described two new species, *adelaidae* and *planicollis*, and gave a table grouping together the known species of the genus, but also including under III. B, several species now placed in *Cubicorrhynchus*.

Lacordaire, in his work (Gen. Coleopt., vi., p. 311, 1863), gave a lengthy description of the genus, without adding any new species to it. He also noted that several of the species ascribed to the genus might be better separated generically; the only one of these with which he was acquainted was *A. planicollis* Waterhouse. This and allied species I have in the present paper placed in a separate section of the genus. Macleay (Trans. Ent. Soc. N.S. Wales, i., 1865, pp. 270-290) described 22 new species,—*transitus*, *amycteroides*, *spinosus*, *crassidens*,

apicalis, humeralis, echidna, denticollis, serraticollis, approximatus, spinifer, howittii, squalidus, truncaticornis, angasi, scabrosus, mucronatus, squamosus, Krefftii, tridentatus, and *crenaticollis.* Later (*op. cit.*, 1866, pp. 327-330) he added 8 more species,—*mastersii, posticalis, rugiceps, irroratus, sublobatus, gravicollis, tribulus,* and *convexiusculus.* Of these 29 species, 10 must go down to synonymy; thus *spinosus* = *lateralis* Bohem; *serraticollis* is but a variety of *denticollis* Macl.; *approximatus* and *angasi* are not specifically distinct from *adelaidae* Waterhouse; *howittii* is the other sex of *spinifer* Macl.; *squalidus* and *truncaticornis* are the same; *mastersii* and *posticalis* are founded on the sexes of the one species; *rugiceps* = *aureolus* Bohem; *irroratus* = *crenaticollis* Macl.; *sublobatus* is founded on the females of *adelaidae* and *squamosus.* One—*convexiusculus*—must be removed from the genus, and I would place it tentatively in *Hyborrhynchus.* In addition to the above, two species described by Macleay as *Cubicorrhynchus* must be placed in *Acantholophus; eximius* has already been referred there by Lea, and in the present paper I have placed *C. maximus* Macl. in *Acantholophus.* In addition, Macleay reviewed the previously described species and divided the genus into groups.

In 1873, Pascoe (Journ. Linn. Soc., Zool., xii. (1876), pp. 6-7) added the names of 3 species,—*gladiator, nasicornis* and *simplex;* of these, *nasicornis* is little more than a variety of *A. aureolus* Bohem. Sloane, in the Scientific Results of the Elder Expedition (Trans. Roy. Soc. S. Aust., xvi., 1892, p. 231), described one new species,—*granulatus.* This name had previously been listed by Schönherr (Mantissa secunda, p. 57, 1847) as a new species of *Acantholophus,* but it was a *nomen nudum,* no description being published, though Waterhouse (*loc. cit.*, p. 2) included it in his table. Blackburn described 4 new species of *Acantholophus,*—*franklinensis* (Trans. Roy. Soc. S. Aust., 1890, p. 92), *niveovittatus* (Proc. Linn. Soc. N.S. Wales, v., 1890, p. 576), *simplex* and *tatei* (Report Horn Exped., 1896, p. 292). Of these, the name *simplex* is preoccupied, and I have already altered the species to *blackburni* (Trans. Roy. Soc. S. Aust., xxxix., 1915, p. 59).

Lea described two species,—*tasmaniensis* (Mitt. a. d. Zool. Mus. Berlin, 1910, p. 182), and *foveirostris* (Mem. Soc. Entom. Belgique, xviii., 1910, p. 85).

Within recent years I have added 9 species to the genus,—*angusticollis, dixoni, brevicornis* (Proc. Roy. Soc. Victoria, xxvii., 1915, pp. 256-259), *browni, alpicola, tennantensis, halmaturinus, simulator* and *scaphirostris* (Trans. Roy. Soc. S. Aust., xxxix., 1915, pp. 66-73). *A. brevicornis* I now regard, however, as merely a geographical race of *A. dumosus* Bohem., *A. tennantensis* as a variety of *A. tatei* Blackb., and *A. simulator* as little more than a variety of *A. tribulus* Macl.

In the present paper I propose the names of 10 species as new, which, with the removal of synonyms, etc., give a total of 57 species for the genus at present known. That this number will be augmented I have no doubt. Possibly also forms which I now regard as varieties of other species will prove with more material to be worthy of specific rank.

Characters of Genus.—Before proceeding to the question of the division of the genus, it may be advisable to discuss the characters at greater length than given in the generic diagnosis; this is the more necessary as it will afford an opportunity of defining some of the terms employed in the description of species.

In the majority of the species the head is concave in front, and, as is best seen from behind, separated from the dorsal surface of the rostrum by a distinct

ridge connecting the inner surfaces of the tubercles or crests which rise above the eyes. This ridge, which will be termed the intercristal ridge, varies in development and is obsolete in some species, while in one section of the genus it is absent, and the division between the head and rostrum is marked by a transverse impression or sulcus. The supraorbital crests, which arise on either side above and somewhat in front of the eyes, show great variation in shape and development, the differences being of decided specific value. As a rule these crests are compound, consisting of two more or less closely united portions, which I have in general termed branches or rami, the posterior of which is almost always pointed. A few species show three distinct branches, generally, however, only separate at the apices. The branches vary much in form and development; sometimes they are more or less obtuse or dentiform, sometimes forming acute spines resembling the branching antlers of a deer. In other species again, the two portions cannot be made out, the crests consisting of a single tubercle or spine. The relation of the intercristal ridge to the supraorbital crests appears to differ somewhat in different groups; in *A. tridentatus* and one or two others, the ridge joins the crests at the base of the median portion; in certain of the bidentate species the connection is clearly with the anterior portion, but in others apparently with the posterior. In many species, however, the crests arise, from a comparatively narrow base into which the ridge runs, and its continuity appears to be with either the posterior or anterior portion, according to the position from which it is viewed. I have not, therefore, been able to make as extensive a use of this character in separating groups of species as I had hoped. In some groups the base of the crests extends for quite an appreciable distance behind the intercristal ridge, in others to a much less extent. On the outer side of the head, in front of the eye, is a deep groove; this generally extends for a short distance on to the outer surface of the crests. In the species where the rostrum is separated from the head by a transverse sulcus, this is generally continued for a short distance on to the inner surface of the crests. The rostrum in *Acantholophus* is always more or less excavate above, with the external margin generally raised and often bearing a distinct tubercle or spine. At the base are two more or less convergent ridges, joining the intercristal ridge; these are often obscure or obsolete. The spaces between these ridges and the lateral margins I have termed the basal foveae; they are generally deep and closed around their margin, but sometimes the external portion of the margin is interrupted. The antennae are long and comparatively slender; the two basal joints of the funicle are longer than the others, but vary in their comparative lengths; the true length of the first joint can only be seen when viewed obliquely from behind. The club varies in length and thickness; in many species the basal portion is attenuated, and I have used the term pedunculate to describe such forms.

The prothorax shows great variation in structure, but the widely explanate upper surface with strongly dentate or tuberculate lateral margins is practically characteristic of the genus. One of the characters upon which I would divide the genus into two sections is the form of the anterior margin; in the majority of species this margin is widely rounded above and slightly produced, with an evident sinuation on each side leading to the formation of a wide and little prominent convexity below corresponding to the ocular lobe; in the species forming the second section, the margin is truncate or subtruncate above, and there is no sinuation nor corresponding ocular lobe. The disc of the prothorax is crossed by three, more or less distinct, transverse impressions or constrictions, of which the

anterior is the most conspicuous and separates off a distinct anterior collar; the middle is, as a rule, only indicated at the sides, where it generally forms a deep indentation between the lateral tubercles; the posterior forms a narrow ring around the base. Longitudinally, in most species, the disc may be divided into three portions; a median area, often more or less raised as a whole, though generally depressed along the median line and bounded on each side by a row of tubercles, which I have termed the submedian row; a sublateral area, without tubercles, but sometimes granulate, and the explanate lateral margins. The submedian tubercles are about 7 in number on each side, the first two being in front of the anterior constriction and the last on the basal constriction; the rest are arranged in one of two ways; in certain species, all the tubercles are in line or little out of it, such I describe as being in single series; in the other type, the intermediate tubercles are what I term exserted, that is, they are more outwardly placed and irregularly arranged, generally with one or two transversely set, the penultimate often elongate, obliquely placed and overhanging the basal constriction. The lateral margins present, broadly, three forms which may be termed tuberculate, spinose and dentate. In the tuberculate form the margins project outwards in two or three flattened, more or less triangular tubercles, of which the one situated immediately in front of the median constriction is the largest and is here termed the median; anterior to this is a smaller tubercle, varying in size and more or less closely fused with the median; behind the median constriction is another large tubercle, smaller than the median, which I term the posterolateral, or briefly the posterior. Anterior to the anterior constriction there is always present a small tubercle on the lateral margin of the anterior collar, which I have not made use of in descriptions, while, between the median and posterior tubercles, a small tubercle or granule is generally present, but lying below their plane.

In the spinose form, the median lateral tubercle is a strong, generally recurved, acute spine, the anterior is generally considerably smaller, while the posterior may be strongly developed and spiniform or represented by a mere spicule. In the dentate forms, the tubercles are less regular and often conjoined, though the median constriction is generally well marked, the three main tubercles being sometimes only traceable with difficulty. In the second section, the median area and submedian tubercles are not, or hardly, marked off from the rest of the disc which is more or less evenly granulate. The sides of the prothorax are convex, and marked by several oblique and irregular grooves.

The elytra are elongate, roughly about three times as long as the prothorax; the base is gently emarginate and bounded by the humeral angles which lie at the junction of the fifth and seventh interstices, the angle generally being marked by a single tubercle; sometimes the bases of the first and third interstices show forward projecting granules or tubercles. The apex is rounded, sometimes with an extreme emargination, or may be slightly produced, particularly in the female, and mucronate. The punctures are always shallow and generally indistinct, sometimes transversely confluent. The interstices bear rows of granules, but these are often confused by the tubercles and are generally only well developed on the first two interstices. Each elytron, with few exceptions, bears three rows of tubercles, situated on the third, fifth and seventh interstices; the first row extends from the base to the edge of the posterior declivity, the posterior being the largest and generally conical or acutely spiniform; the second row starts farther from the base and as a rule extends slightly beyond the first row posteriorly, the

tubercles of the row being generally all conical, though the posterior ones are larger; the third row is situated on the basal portion of the seventh interstice and may be represented by only one or two tubercles. The humeral tubercle belongs neither to the second nor third rows, being situated at the confluence of the fifth and seventh interstices. The other interstices bear no tubercles, except occasionally the posterior portion of the second; while the fourth and sixth are only traceable with difficulty. The sides are more or less inflexed and the interstices granulate, often obsoletely, above. The ventral surface is plane in the male or lightly transversely convex, with the basal segments somewhat depressed; in the female the abdomen is convex antero-posteriorly and transversely. The anterior coxae are subcontiguous, almost, but not quite, touching. The tibiae often possess characters, generally sexual, of specific importance. The anterior tibiae are for the most part uniform in structure except in *A. denticollis* where there is a deep subapical emargination in the male. The intermediate tibiae possess sexual characters in many species in the form of a deep subapical emargination. The corbels of the posterior tibiae require a rather fuller description; these are more or less oval, with an anterior extension somewhat triangular in shape, and generally inclined at an angle to the plane of the rest of the corbel. The setae surrounding the corbel are interrupted at the extension which generally has a few setae more irregularly arranged or in clumps. This extension varies much in development, shape, and degree of development in the buttress which supports it from the anterior surface of the shaft; these variations may be sexual, as in *A. scabrosus*, but generally the characters are similar in both male and female. The posterior tarsi are more or less elongate, but shorter and broader in some species than in others.

Dissections have been made of the male genitalia in several species. These have shown that the structures do not differ fundamentally, though showing variation in the shape of the median lobe and in the form of the internal sac. I am deeply indebted to Dr. David Sharp and to Mr. F. Muir for a better knowledge and understanding of the anatomical arrangement of the parts of the male genitalia. The eighth sternite shows no variation,—it is partially chitinised in the form of a pair of roughly triangular pieces which do not quite meet in the median line. In a private letter Dr. Sharp states that the last ventral segment (*i.e.*, the eighth) in *Acantholophus* is in the condition normal for Rhyncophora.

Relation to Other Genera.—*Acantholophus* is related on the one hand to *Cubicorrhynchus*, and on the other to *Hyborrhynchus*. The point of distinction between *Acantholophus* and *Cubicorrhynchus* is not altogether easy to make; the character on which I rely to separate the two genera is the upper rostral surface. In *Acantholophus* this is always to some extent excavate, and never presents the broad flat appearance so characteristic of *Cubicorrhynchus*. For this reason I place *C. maximus* in *Acantholophus*, as it has a deeply excavate rostrum, though in general its facies resembles that of *Cubicorrhynchus*; it is, however, certainly congeneric with *A. granulatus* Sloane and *A. blackburni* Ferg. (= A. *simplex* Blackb.) which their authors placed unhesitatingly in *Acantholophus*. The species of *Cubicorrhynchus* are for the most part smaller than those of *Acantholophus*, and with few exceptions do not possess elytral tubercles. The species here grouped together under section II. possess many features in common with *Cubicorrhynchus* and at variance with the other section of *Acantholophus*, which, however, they resemble in their general facies. Probably this section will eventually be constituted a separate genus.

From *Hyborrhynchus* the present genus differs more widely; the arrangement of the rostral and head tubercles is different, but the chief point of distinction lies in the relation of the bases of the prothorax and elytra. In *Acantholophus* the base of the prothorax is practically as wide as the space between the humeral angles which are at the junction of the fifth and seventh interstices; in *Hyborrhynchus*, as in *Anascoptes* and allied genera, the base of the prothorax is measured by the distance between the ends of the third elytral interstices.

Subdivision of the Genus.—Macleay in his paper subdivided the genus into 4 groups:—

A. With simple tubercle over the eye.
  a. Three rows of tubercles on each elytron.
  b. Two rows of tubercles on each elytron and one or two post-humeral lateral spines.

B. With compound tubercle over the eye.
  a. Two rows of tubercles on each elytron and under 4 lateral spines.
  b. Three rows of tubercles on each elytron.

This classification followed on the lines of the table given by G. R. Waterhouse (*l.c.*, p. 1, 1854) for the few species known to him. Waterhouse, however, included in his table species that were afterwards placed in *Cubicorrhynchus* and *Hyborrhynchus*.

Macleay's arrangement is, however, by no means satisfactory, as, according to his grouping, the first 3 groups each contained three to six species, while the bulk of the species was placed in group 4 which thus included many dissimilar species.

In endeavouring to group the species together on a satisfactory basis, I have experienced great difficulty in deciding what should be regarded as primary characters, and the arrangement now suggested can only be regarded as tentative. The difficulties arise partly from the great variation in so large a genus, and partly from similar characters being sometimes present in members of what are otherwise remotely separated groups. This, in some cases, appears to be due to convergence of characters, in others possibly to the reappearance of an ancestral character. The simple or single form of the supraorbital crests is an example of the first; in several groups there appears a tendency to the formation of a single crest either by the complete fusion of two rami or by the suppression of one ramus, while in other instances the simple form seems almost a primitive character. As an example of what I have termed the reappearance of an ancestral character may be cited the subapical emargination or notch on the intermediate tibiae. This occurs throughout all the species of one or two groups, but also occurs in perhaps one or two species in a group, the other members of which do not possess this character. The notch also occurs in genera such as *Sclerorinus* and *Talaurinus* which are not nearly related to *Acantholophus*.

While, therefore, there occur groups of species all the members of which resemble each other closely in general facies, it is not always easy to define the characters or limits of such groups. In the accompanying table of species, therefore, while endeavouring to arrange the species according to their evident affinities, the characters selected for the purpose of the table are not always what I would regard as of primary importance.

The genus as a whole, however, falls readily into two sections. In the first, the head is separated from the rostrum by the intercristal ridge; the prothorax is produced above and ocular lobes are present. The greater number of species

fall into this section. In the second section, the head is separated from the rostrum by a transverse impression; the prothorax is subtruncate above, and ocular lobes are absent. In these characters the second section agrees with the genus *Cubicorrhynchus*, and with good reason might be united to that genus; the species, however, in their general facies, much more closely resemble *Acantholophus*, and the rostrum is deeply excavate. Probably this section will require a new generic name.

The members of the first section may be divided further into tuberculate and spinose forms; this differentiation is not a good one as, after all, it is more or less a question of degree, but the division serves to separate two large groups of species, the members of each of which are more or less closely allied *inter se.* I have taken the character of the lateral prothoracic tubercles as determining whether a species belongs to the tuberculate or spinose subsection. In one or two cases it is difficult to interpret this feature, but most of the doubtful species are evidently related to other species belonging to one or other of these two subsections. In the tuberculate forms the submedian rows of prothoracic tubercles are never in single series, but always have the intermediate tubercles irregularly set (exserted). In the spinose subsection these submedian tubercles are generally in single series, but may be exserted. Further subdivision into groups is a matter of great difficulty, principally owing to the occurrence of so many isolated species, each more or less requiring a group to itself. Certain natural groups do occur, and in the table of species I have indicated such groups by the group name in brackets after the character which immediately governs the group. Such group names have only been made use of in the tuberculate subsection.

TABLE OF SPECIES.

Section I.—Rostrum divided from head above by an intercristal ridge. Apical margin of prothorax slightly produced above head, with ocular lobes.

1 (54) Lateral prothoracic tubercles flattened, trianguliform. [Submedian row of tubercles on prothorax not in single series]. (*Tuberculate* species).
2 (11) With the following characters in combination: Supraorbital crests simple; intermediate tibiae notched (*dumosus* group).
3 (6) Intercristal ridge well developed.
4 (5) Intermediate ventral segments strongly strigose; subapical elytral spines absent or mere spicules .. .. *dumosus* Bohem.
5 (4) Intermediate segments not strigose; subapical spines well marked. *apicalis* Macl.
6 (3) Intercristal ridge obsolete or but little developed.
7 (10) Prothoracic tubercles depressed, flattened.
8 (9) Form normal; tubercles few and large. .. .. .. *transitus* Macl.
9 (8) Form very elongate; tubercles more numerous and smaller. *browni* Ferg.
10 (7) Prothoracic tubercles erect, conical .. .. *amycteroides* Macl.
11 (2) Without the combination of characters as in *dumosus* group.
12 (49) Apical tubercle of second elytral row on a level with, or posterior to apical tubercle of first row.
13 (42) Apical ventral segment more or less flattened.
14 (39) Supraorbital crests arising from a comparatively broad base. (*marshami* group).
15 (34) Crests more or less distinctly branched.
16 (33) Crests distinctly biramate.
17 (20) Posterior tarsi with first joint short and broad.
18 (19) Intermediate tibiae simple. .. .. *marshami* Kirby.
19 (18) Intermediate tibiae notched. .. .. *sellatus*, n.sp.

20 (17) Posterior tarsi with first joint elongate and comparatively slender.
21 (32) Middle and posterior tibiae simple.
22 (23) Intermediate ventral segments strongly strigose .. .. .. *echidna* Macl.
23 (22) Intermediate segments setigero-punctate, but not strigose.
24 (27) Antennae with joints of funicle elongate; club with slender peduncle.
25 (26) Narrow elongate species (♂); strongly mucronate posteriorly (♀). *mucronatus* Macl.
26 (25) Relatively stouter species (♂); briefly mucronate (♀). *echinatus* Guer.?
27 (24) Antennae with joints less elongate; club briefly or not pedunculate.
28 (29) Crests with deep notch between rami. .. .. *spinifer* Macl.
29 (28) Crests with shallow notch between rami.
30 (31) Mandibles transversely rugose beyond inner smooth margin. *sordidus*, n.sp.
31 (30) Mandibles more closely and not transversely punctured. *subtridentatus*, n.sp.
32 (21) Intermediate tibiae notched, posterior tibiae with a flange-like process on inner side of apex. .. .. *scabrosus* Macl.
33 (16) Supraorbital crests distinctly triramate. .. .. *tridentatus* Macl.
34 (15) Supraorbital crests apparently single (division between branches occasionally indicated in individual specimens).
35 (38) Elongate, narrow species.
36 (37) Tubercles low and obtuse. .. .. *alpicola* Ferg.
37 (36) Tubercles distinct and conical. .. .. *tasmaniensis* Lea.
38 (35) Shorter, relatively broader species. .. .. *dixoni* Ferg.
39 (14) Supraorbital crests arising from a narrow base, erect, feebly notched at apex.
40 (41) Prothoracic tubercles flattened; intermediate tibiae notched. *foveirostris* Lea.
41 (40) Prothoracic tubercles rounded; intermediate tibiae simple. *squalidus* Macl.
42 (13) Apical ventral segment antero-posteriorly convex, the posterior slope slightly transversely flattened. .. .. (*adelaidae*-group).
43 (48) Prothorax with apical tubercles of submedian row not strongly cristaform.
44 (47) Supraorbital crests feebly or not bidentate.
45 (46) Short species, with fewer elytral tubercles. .. .. *adelaidae* Waterh.
46 (45) Elongate species with relatively narrower prothorax, and more numerous elytral tubercles. .. .. *angusticollis* Ferg.
47 (44) Supraorbital crests distinctly branched. .. .. .. *halmaturinus* Ferg.
48 (43) Prothorax with anterior tubercles of submedian rows strongly cristaform. *gravicollis* Macl.
49 (12) Apical tubercle of second elytral row anterior to apical tubercle of first row. .. .. (*squamosus* group).
50 (53) Intermediate tibiae simple.
51 (52) Apical tubercle of first row the largest. .. .. *squamosus* Macl.
52 (51) Penultimate tubercle of first row the largest. .. .. *nanus* n.sp.
53 (50) Intermediate tibiae with strong subapical notch. .. *parvulus*, n.sp.
54 (1) Lateral prothoracic tubercles more or less spiniform. (*Spinose* species).
55* (62) Supraorbital crests composed of two separate tubercles or spines, the intercristal ridge connecting the anterior pair.
56 (59) Posterior tibiae with a strong forward projecting process at apex.
57 (58) Spines on head, prothorax and elytra long and acute. .. .. *kreffti* Macl.

* Two species have been incorrectly included here. *A. kreffti* has the crests deeply divided, but the two branches hardly arise separately; in *A. doddi* the branches are united for a considerable distance. In the Table both species should come before *A. tatei*, etc., from which they can be separated by the tibial structure.

58 (57) Spines noticeably shorter. .. .. *doddi*, n.sp.
59 (56) Posterior tibiae simple.
60 (61) Ovate, strongly convex, very spinose species. .. .. *hystrix* Bohem.
61 (60) Small, narrow, elongate; tubercles conical. .. .. .. *bivittatus* Bohem.
62 (55) Supraorbital crests simple or compound, the rami never arising separately.
63 (66) Lateral prothoracic tubercles subcylindrical, or peg-like.
64 (65) Crests biramate, the rami slender. .. .. *tribulus* Macl.
65 (64) Crests with rami stouter; the lateral prothoracic tubercles shorter. *simulator* Ferg.
66 (63) Lateral prothoracic tubercles acute.
67 (68) Elytra rounded at base, without humeral angles. .. .. *mastersi* Macl.
68 (67) Elytra with more or less marked humeral tubercles.
69 (78) Subapical elytral spines present.
70 (71) Supraorbital crests single. .. .. *gladiator* Pasc.
71 (70) Supraorbital crests compound.
72 (75) Crests triramate.
73 (74) Elytral tubercles few and separate. .. .. *niveovittatus* Blackb.
74 (73) Elytral tubercles of first row smaller, more numerous and more closely set. .. .. *franklinensis* Blackb.
75 (72) Supraorbital crests biramate.
76 (77) Subapical spines well developed, acute. .. .. .. *hypoleucus* Bohem.
77 (76) Spines mere spicules; crests larger and thicker. .. .. *crassidens* Macl.
78 (69) Elytra without subapical spines.
79 (82) Apical tubercle of submedian prothoracic row distinctly larger than others of the row.
80 (81) Large, elongate species. .. .. *suturalis* Bohem.
81 (80) Shorter, more ovate species. .. .. *lateralis* Bohem.
82 (79) Apical tubercle of submedian prothoracic row not longer than others of the row.
83 (88) Supraorbital crests arising from a comparatively broad base behind the intercristal ridge.
84 (87) Intermediate tibiae with a deep subapical notch in ♂.
85 (86) Clothing markedly vittate. .. .. *humeralis* Macl.
86 (85) Clothing of elytra uniform. .. .. *cupreomicans*, n.sp.
87 (84) Intermediate tibiae simple. .. .. *ocelliger*, n.sp.
88 (83) Supraorbital crests arising from a comparatively narrow base.
89 (92) Prothorax with submedian row of tubercles in single series.
90 (91) Crests compound. .. .. *tatei* Blackb.
91 (90) Crests simple. .. .. *tragocephalus*, n.sp.
92 (89) Prothorax with tubercles of submedian row irregularly arranged in centre. .. .. *simplex* Pasc.

Section II.—Rostrum separated from head by a transverse groove; prothorax not produced over head, ocular lobes absent:—

93 (104) Lateral prothoracic margins with outwardly projecting trianguliform tubercles.
94 (101) Posterior, lateral, prothoracic tubercle strongly developed.
95 (98) Elytral tubercles strong, spinose.
96 (97) Supraorbital crests simple. .. .. *aureolus* Bohem.
97 (96) Supraorbital crests bidentate. .. .. *nasicornis* Pasc.
98 (95) Elytra granulate, without definite tubercles.
99 (100) Supraorbital crests triramate. .. .. *crenaticollis* Macl.
100 (99) Supraorbital crests biramate. .. .. *terrae-reginae*, n.sp.
101 (94) Posterior, lateral, prothoracic tubercle granuliform.
102 (103) Elytral punctures and granules distinct. .. .. *eximius* Macl.

103 (102) Elytral punctures and granules much less distinct. .. *scaphirostris* Ferg.
104 (93) Lateral margins of prothorax more irregularly dentate.
105 (110) Elytral tubercles more or less distinct.
106 (107) Anterior tibiae simple. .. .. *planicollis* Waterh.
107 (106) Anterior tibiae with subapical notch.
108 (109) Supraorbital crests simple. .. .. *denticollis* Macl.
109 (108) Supraorbital crests bidentate. .. .. *serraticollis* Macl.
110 (105) Elytra granulate, not tuberculate.
111 (114) Form comparatively slender, resembling *Acantholophus*.
112 (113) Supraorbital crests single; elytral granules duplicated on some of the interstices. .. .. *granulatus* Sl.
113 (112) Supraorbital crests bidentate; elytral granules in single series. *blackburni* Ferg.
114 (111) Form robust, resembling *Cubicorrhynchus*; elytral granules in double series. .. .. *maximus* Macl.

Geographical Distribution.—The genus has probably as wide a distribution as any of the subfamily, with the possible exception of *Cubicorrhynchus*. It is noteworthy in this connection that *Acantholophus* occurs in Tasmania, whereas *Cubicorrhynchus* has never been recorded from that island. Section II., though few in numbers, has a distribution practically co-extensive with the genus, though apparently the south-west has more species belonging to this section than any other portion. Both the eastern and western sides of the continent are rich in species of Section I.; but with the difference, that whereas tuberculate forms predominate on the eastern side, spinose species are dominant in the west. The species included in the *dumosus* group afford the most striking exception to this generalisation; the headquarters of these is in the south-west, but the group spreads into South Australia and touches the mallee district of Victoria. Almost the only spinose species in the eastern portion of the continent are two that occur in Queensland. The species of southern Australia mostly fall into the small *adelaidae* group. Central Australia, as far north as Tennant's Creek, possesses a few species, and it is noteworthy that these are closely related to forms occurring in north-west Australia, where the genus has been met with as far north as Condon. No species have so far been recorded from the far north. *Cubicorrhynchus* has a similar distribution, but whereas that genus frequents the open plains and inland slopes, *Acantholophus* appears to prefer the mountain ranges. This generalisation is based on my knowledge of the two genera in Eastern Australia, and I cannot say if the same holds good for other parts. On the east, however, the genus is widely distributed along the Main Dividing range and on the sandstone formation of the Sydney basin; where it occurs farther inland it is, as a general rule, on the spurs and ranges such as the Warrumbungles, which are offshoots from the main chain.

Habits.—Specimens are most often taken under logs and stones, or crawling along paths at dusk or in the early morning. At least one species—*A. marshami*—can be taken around Sydney at the base of grass-trees (*Xanthorrhoea*), and Mr. Clark, of Perth, informs me that other Western Australian species have this habit. I have also received specimens of *A. simulator* from Mr. A. M. Lea marked as taken in grass-trees.

Recently, when this manuscript was well nigh complete, I received from Mr. J. Clark valuable notes on the habits of many of the Western Australian species, which seem worthy of being recorded *in extenso*:—"I am quite satisfied that the majority of our W.A. *Acantholophus* feed on the bark of trees, mostly Marri

(*Euc. calophylla*), but they take to several other trees, not all Eucalypts. I am also of the opinion that the larvae feed on the roots of grass-trees, but have so far got no proof. It is mostly in grass-tree country that the whole sub-family abound, although I have got a few far from such country. Dead and living grass-trees attract members of the Family, but for what purpose I do not know. Of all the species I have taken on and in grass-trees, I have seen no signs of foliage or leaf base having been touched by them; most of the species taken in dead grass-trees are found in small cavities which they seem to have dug in the decaying heart or pith, but I do not think they have pupated there, as the cell is clearly the work of the adult, who prefers the decaying heart of the grass-tree as food, the larval and pupal stages being passed in the *roots?*"

"Of the species under loose bark on trees, they eat the bark from within outwards, leaving the sap alone so that they do not interfere with the health of the tree, except that they keep the bark loose and so help other agencies to work on the trees. I have taken over a dozen on one tree on many occasions. Most of the species taken on the ground (all genera) are mostly at the foot of a tree with fresh bark lying around, on which they have been feeding, this particularly applies to *Cubicorrhynchus*, and these are sometimes taken under the loose bark on the trees. Several others seem to live in or on decaying timber such as *Ac.* (*Cubi.*) *maximus*, which is only to be taken under rotting timber or stones, and nowhere else, and always on rough stony or hilly country. Those species taken on the hilly country are rarely met with on the sandy plains and *vice versa*."

Mr. Clark has also furnished me with a list of Western Australian *Amycterides* known to him, with notes as to habits, etc., from which I have taken the following entries relating to individual species of *Acantholophus*.

"*A. gladiator* Pasc.—I have taken about a dozen, but always in tussocks or other small thick-growth. I fire the clump and drive them out.

A. transitus Macl.—About 7 specimens taken, all on the ground under bits of timber, etc. I can get this species in one place only, it seems somewhat rare.

A. amycteroides Macl.—Numerous in dead grass trees, and under loose bark of various trees, also a few amongst the foliage of living grass-trees and sometimes under logs.

This and the following species seem to prefer the hilly country, and are the most commonly met species.

A. suturalis Bohem.—Similar to above, but is sometimes taken on the low sandy country.

A. spinosus Macl.—Confined to the low sandy country, and usually on the ground under timber, bark, etc., but sometimes taken under loose bark on trees. A peculiar feature of this species is that they usually occur in pairs, but not "*in cop*," and never numerous.

A. aureolus Bohem.—Usually under loose bark or in dead grass-trees. Mostly on the hills.

A. nasicornis Pasc.—One specimen, under timber on ground.

A. niveovittatus Blackb.—Always on the ground, under logs, etc.

A. hypoleucus Bohem.—On the ground, and under loose bark; hilly country.

A. dumosus Bohem.—Same as above.

A. crassidens Macl.—One specimen only, under bark of Marri.

A. humeralis Macl.—I have never taken this species.

A. hystrix Bohem.—Not taken by me.

A. scaphirostris Ferg.—One specimen under stone.
A. cupreomicans n.sp.—Under bark of Marri.
A. maximus Macl.—Only on the ground, under stones, timber, etc."

ACANTHOLOPHUS DUMOSUS Bohem.

Bohemann, Schönh., Gen. Spec. Curc., vii., i., 1843, p. 77; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 272.

♂. Black; clothing sparse, dark, irregularly maculate with white on elytra, forming an irregular vitta along suture, on sides forming maculae above and an interrupted vitta along lower margin.

Head concave in front; intercristal ridge conspicuous; supraorbital crests short, simple, briefly pointed, arising from ends of intercristal ridge and from head immediately posterior to it. Rostrum rather shallowly concave, lateral margins feebly angulate, sometimes with a small tooth anteriorly; internal ridges not conspicuous, strongly convergent posteriorly; basal foveae large, closed. Antennae of moderate length, funicle with second joint longer than first, club briefly pedunculate. Prothorax flattened, median area obsoletely granulate; submedian tubercles small, granuliform, obsolescent in centre, the apical pair slightly larger, not arranged in single series; lateral tubercles flattened, trianguliform, the median one large, somewhat spiniform, curved backwards at apex, with a small tubercle conjoined anteriorly, posterior lateral tubercle trianguliform, almost as large as median, not recurved. Elytra rather short, with granules somewhat irregularly disposed; with three rows of tubercles, first row with 8—10, mostly granuliform, the last 2 only acute and spiniform, ending on declivity, sometimes with a few spicules beyond; second row with 6—7, the basal tubercles conical, the last 3 acutely spiniform; humeral tubercle large and conical; third row with 4 outwardly projecting spiniform tubercles. Ventral surface coarsely strigose. Intermediate tibiae notched.

♀. Larger than ♂ and broader and stouter; prothorax similar, elytra with fewer, more widely separated tubercles, 8—9, 5 and 3 on the three rows, no subapical tubercles; undersurface convex, ventral segments almost as coarsely strigose as in ♂. *Dimensions*: ♂. 16 × 6 mm.; ♀. 20 × 8 mm.

Hab.—Western Australia: King George Sound, Mundaring Weir, Tenindewa.

The specimen from Tenindewa (♂) has rather longer crests and two distinct spicules on declivity in line with first row; it is also somewhat narrower. I do not think it is distinct as I find that specimens show a tendency to vary in these respects. A ♂ labelled "N. Territory" is considerably more slender than King George Sound specimens, but I cannot separate it, and furthermore I believe the locality to be incorrect.

A dumosus Boh., is more nearly allied to *A. apicalis* Macl., but can be readily distinguished by the absence of subapical tubercles on the elytra, and by the differently sculptured ventral surface. The other species of the group differ widely in many respects.

ACANTHOLOPHUS DUMOSUS Boh. var. BREVICORNIS Ferg.

Proc. Roy. Soc. Victoria, xxvii. (New Series), Pt. ii., 1914, p. 257.

I now regard this species as a geographical race or variety of *A. dumosus* Boh., the distinctions not appearing sufficient to justify specific rank. The occur-

rence of this species and of *A. humeralis* Macl., in western Victoria furnish instances of disconnected distribution which are almost unparalleled among the Amycterides.

ACANTHOLOPHUS APICALIS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 276.

♂. Closely allied to *A. dumosus* Boh. Black; clothing indistinct, greyish, somewhat denser on sides.

Head rather deeply concave in front, with three indistinct impressions above, converging on concavity; intercristal ridge well developed, more strongly curved backwards at ends; supraorbital crests simple, arising to a great extent from behind the ends of ridge. Rostrum somewhat longer and narrower than in *A. dumosus*, lateral margins slightly sinuate in middle, obtusely angulate anteriorly; internal ridges distinct, strongly convergent; basal foveae large and deep. Antennae with second joint of funicle hardly longer than first, club large, not pedunculate. Prothorax with median area free from granules, submedian tubercles distinctly larger and obtusely conical, not in single series, the central ones more outwardly placed; lateral tubercles as in *A. dumosus*. Elytra narrower and considerably longer than in *A. dumosus;* granules larger, more distinct and more regularly set; tubercles smaller, conical but less acutely spiniform; first row with 11—13, the basal tubercles small and rounded, the last 2—3 becoming larger and more conical and acute, ending on edge of declivity; second row with eight, rather closely set, conical tubercles, larger posteriorly, and reaching a lower level on declivity than first row; humeral tubercle large and conical; third row with 5, the first large and conical, the others becoming progressively smaller; a pair of strong subapical tubercles present. Ventral surface not strigose, rather closely set with fine decumbent setae arising from small, shallow punctures, somewhat more evident on apical segment. Legs with intermediate tibiae notched.

♀. Larger, more ovate; elytra broader, with tubercles reduced to mere granules, hardly larger than the other granules, only the last two of first, and the last three or four of second row at all larger and conical, though smaller than corresponding ones in ♂; humeral tubercle and first tubercle of third row moderately large, followed by a row of 6 granules; subapical tubercles large as in male. Venter convex. Legs simple. *Dimensions*: ♂ 18 × 6 mm.

Hab.—South Australia: Mt. Lofty.

Closely allied to *A. dumosus* Bohem., the present species may be distinguished by its more elongate form, with the presence of large subapical tubercles, and by the differently sculptured ventral surface.

On the name label of this species in the Macleay Museum there are two males; as is usual neither is marked as type.

ACANTHOLOPHUS AMYCTEROIDES Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 271.

♂. Large. Black; moderately densely clothed with brown subpubescence; elytra with a greyish vitta posteriorly between the first and second rows of tubercles, extending down and most marked on declivity, with another, somewhat interrupted, between second and third rows; sides with a grey vitta running along middle of sides of prothorax and along lower margin of elytra, with a few macules above on elytra.

Head concave in front; intercristal ridge absent, the continuity of head and rostrum interrupted above by a slight difference in level; supraorbital crests simple, appearing as a prolongation upwards of the lateral margins of the rostrum, apex briefly pointed, directed upwards. Rostrum rather shallowly concave above, with a deep median impression, foveiform anteriorly; lateral margins raised, parallel for greater part of length, slightly divergent and obtusely angulate anteriorly; internal ridges and foveae obsolete. Antennae moderately long, scape rather stout, somewhat curved, first joint of funicle shorter than second, club elongate, fairly stout, pedunculate. Prothorax with median area with a central carina in posterior half; submedian tubercles distinct, erect, noduliform, 7 in number, the central ones exserted; lateral tubercles trianguliform, the median the largest, with apex somewhat recurved, the anterior smaller, but separate, except at base, the posterior slightly smaller than median and more obtuse. Elytra with granules most distinct along suture; with three rows of moderately large, conical, tubercles, first with 6—7, rather small and obtuse, the last 2 larger and spiniform, ending on edge of declivity; second with 5—6, all conical, the last 3 larger and spiniform, reaching a lower level on declivity than first row; humeral tubercle moderately large; third row with 4—5, moderately large and conical, but decreasing rapidly in size posteriorly. Ventral segments obsoletely punctate, with fine subsetose pubescence, thinly set, but condensed at sides. Intermediate tibiae with a strong subapical notch.

♀. Larger, more robust than male; elytra much broader and more ovate, with more evident granules, tubercles smaller, first row with 7, the last three stronger and more conical, second with 7, larger posteriorly, third with 5. Venter convex, obsoletely punctate; intermediate tibiae simple. *Dimensions*: ♂ 16 × 6 mm.; ♀. 18 × 9 mm.

Hab.—Western Australia: King George Sound, Parkerville.

A male from Canning Ranges is larger and differs somewhat in the supraorbital crests, which do not appear so much like a continuation of the lateral rostral margins, but apparently arise somewhat internal to them; the lateral prothoracic tubercles are also larger, with the anterior and median tubercles almost completely conjoined and more strongly directed back at the apex; the posterior is also more acute; the elytral tubercles are stronger and more numerous, 8, 8 and 6 in number in the three rows. A female from Kalamunda resembles the above male in the supraorbital crests; the elytral tubercles number 9, 8 and 5. I do not however, think these differences are of specific importance.

The species can be readily recognised among the other members of the group by the rounded nodules on the prothorax, not flattened as in *A. transitus* nor with the anterior pair enormously developed as in *A. gladiator*.

ACANTHOLOPHUS TRANSITUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 271.

♂. Large. Black; sparsely clothed with grey subpubescence, elytra more densely vittate with grey between first and second rows of tubercles and between second and third rows; sides vittate above and below.

Head deeply concave in front, with a single median carina; intercristal ridge represented by short oblique ridges running from the ends of the internal rostral ridges to the crests; supraorbital crests single, short, little raised, and obtuse. Rostrum with upper surface rather shallowly excavate and rugosely punctate;

lateral borders raised, angulate in front, posteriorly running into base of supra-orbital crests; internal ridges strongly convergent, only evident at base; basal foveae deep. Antennae rather stout, first joint of funicle shorter than second, club stout, briefly pedunculate. Prothorax flattened; median area with an irregular, impressed, median line, set with flattened, little raised granules of varying size; submedian tubercles similarly flattened, noduliform, varying in size and shape, irregularly set; lateral tubercles broadly trianguliform, the anterior almost completely conjoined with median, and the posterior as large as median. Elytra moderately elongate, shorter than in *A. browni;* punctures small and indistinct; granules small, but regularly arranged; first row of tubercles 8—9 in number, basal ones small and granuliform, the last 3—4 becoming larger and more conical, ending on edge of declivity; second row with 6—7, all conical, but smaller at base, ending at a lower level on declivity, with a small spicule beyond last tubercle; humeral tubercle large and conical; third row with 4, conical outwardly projecting tubercles, the first the largest. Ventral surface set with large, rather shallow punctures, the intervals slightly raised or strigose, punctures filled with large subsquamose setae. Intermediate tibiae with a rather shallow subapical notch.

♀. Very large, with broad elytra; first row of tubercles granuliform, the last 2—3 small conical tubercles; second with 10, all small, but larger than first row, and conical posteriorly; third with 6. Venter convex, obsoletely punctate, with small subsquamose setae in the punctures. *Dimensions*: ♂. 19 × 7 mm.; ♀. 23 × 9.5 mm.

Hab.—Western Australia: King George Sound, Coreongenup, Swan River.

A male from Swan River has the ventral segments all coarsely punctate with the interstices raised and strigiform.

On the name label in the Macleay Museum are two males from Swan River; one has the ventral sculpture almost obsolete as in the ♂ described above, the other is coarsely strigose as in the Swan R. male; the tubercles are 8—9, 7—8, 3—4 in the one male, and 8—9, 7—9, 4—5 in the second. The difference in the sculpture of the ventral segments I cannot regard as of specific value; it seems more probably an individual variation.

Apart from the following species, *A. browni* Ferg., the present one is most closely related to *A. amycteroides* Macl., but differs, *inter alia*, in the flattened prothoracic tubercles.

ACANTHOLOPHUS BROWNI Ferg.

Ferguson, Trans. Roy. Soc. S. Australia, xxxix., 1915, p. 66.

This species is closely allied to *A. transitus* Macl., but may be readily distinguished by its much more elongate form, with more numerous and smaller elytral tubercles.

Hab.—Western Australia: Ankertell.

ACANTOLOPHUS MARSHAMI Kirby.

Curculio marshami, Kirby, Trans. Linn. Soc., xii., 1818, p. 436; Gyllenhall, Schönh. Gen. Spec. Curc., ii., 1834, p. 472; Boisduval, Voy. de l'Astrolabe, ii., 1835, p. 369; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 279; Lea, Mém. Soc. Ent. Belgique, xviii., 1910, p. 86.

♂. Clothed with obscure brownish subpubescence, prothorax feebly vittate with grey in middle line.

Head concave in front, with a rather low, but distinct intercristal ridge; supraorbital crests rather obtuse and stumpy, the two rami about equal in length, projecting forwards and upwards and little divergent; intercristal ridge running into base of anterior ramus. Rostrum short and broad, concave above, with external margins obtusely angulate in front of middle, low posteriorly; internal ridges moderately distinct; basal foveae well defined. Antennae with first joint of funicle shorter than second; club elongate, pedunculate. Prothorax with submedian tubercles low, noduliform, the apical ones not larger nor conjoined, not in single series, the middle ones more outwardly placed; sides explanate-tuberculate, the tubercles flattened trianguliform, the anterior conjoined with median, which is the largest, the posterior well-developed but shorter than median. Elytra with rows of somewhat obscure punctures, and with granules varying in development, sometimes obsolete; with three rows of tubercles, varying in number and somewhat in size, the first row with 8—10, the basal ones small and noduliform or hardly larger than granules, becoming larger and more acute posteriorly and ending on edge of declivity; second row with 6—8, larger and more acute posteriorly and ending slightly farther down on declivity than first row; humeral tubercle small but acute, followed by third row of 5 outwardly projecting tubercles, becoming smaller posteriorly. Venter nitid with moderately coarse punctures, the apical segment rather coarsely strigose, with punctures confluent. Intermediate tibiae simple; posterior tarsi with first joint short and broadened to apex.

♀. Larger and more obese; head and prothorax similar; elytra broader with evident rows of granules, tubercles smaller and more obtuse; venter convex, with punctures as in male. *Dimensions*: ♂. 17 × 7 mm.; ♀. 19 × 8.5 mm.

Hab.—N.S. Wales: Sydney, Illawarra.

There exist two forms of this well-known species which I was inclined at first to regard as separate species, but a longer series shows that the characters which distinguish them are variable. In some specimens the elytral tubercles are fewer and more widely separated, while they are also slightly larger and more acute; the interstitial granules are obsolete or little evident. In the other form the tubercles are more numerous, smaller, and more obtuse, while the granules may be very conspicuous, particularly on the sutural and second interstices. Intermediate forms between the two extremes, however, occur. Probably the type belonged to the more granulate form, as the granules are mentioned in the original description.

The species may be distinguished from other members of the group, with the exception of *A. sellatus*, by the much broader and shorter posterior tarsi. From *A. sellatus* it is distinguished, *inter alia*, by the simple intermediate tibiae.

The species is not uncommon about Sydney, and lives in the roots of the grass-trees (*Xanthorrhoea*), a habit possessed by some Western Australian and South Australian species. Specimens in the collection of the late H. W. Cox were labelled Illawarra; probably they were taken near Otford and on the sandstone formation.

Masters' Catalogue gives two synonyms under *A. marshami,—echinatus* (Dej. Cat., 1st Ed., p. 64) and *sepidioides* (Latr., Dej. Cat., 3rd Ed., p. 289)—but these names appear to be *nomina nuda*.

ACANTHOLOPHUS SELLATUS, n.sp.

♂. Black, rather densely clothed above, except on tubercles, with brown subpubescence, prothorax and elytra obscurely vittate with grey.

Head strongly concave in front, supraocular crests large, broad at base, with the two rami almost completely fused, the anterior ramus not projecting forward, rounded above, separated from posterior by a slight indentation on free margin, the posterior prolonged as a strong conical process; intercristal ridge strongly raised, running into base of anterior portion of crests. Rostrum widely and moderately deeply concave in front, with lateral margins strongly angulate in middle; internal ridges widely divergent anteriorly, basal foveae small but evident. Antennae with second joint of funicle longer than first; club elongate-obovate. Prothorax (4.5 × 5 mm.) with feeble ocular lobes; median area rather broad in middle, median tubercles consisting anteriorly of a pair on each side, conjoined to form short parallel ridges, in centre of a group of rounded, somewhat depressed, confused tubercles, and posteriorly of a large, strong, backwardly projecting tubercle on each side, strongly convergent and obliquely set, their inner surfaces looking upwards and inwards; lateral margins with a pair of conjoined tubercles in front of middle, triangular, flattened above, and with a single smaller tubercle posterior to middle. Elytra (11 × 6.5 mm.) elongate, only moderately widened posteriorly; punctures obscure, and granules small and indefinite; sutural interstice with a slightly elevated ridge on each side of base; with three rows of moderately strong spinose tubercles, first row with 7 tubercles, the basal ones smaller and not conical, the last 2—3 conical and ending at edge of declivity; second row with 7, projecting outwards and upwards, ending at level of declivity; third row with humeral tubercle large, but smaller than following one, and 5 other spinose tubercles, extending to middle of elytron. Lateral interstices somewhat obsoletely granulate. Under surface rather closely set with moderately long black setae arising from small punctures, the apical segment more asperate-punctate. Legs with intermediate tibiae strongly emarginate above apex; posterior tarsi with first joint comparatively short and stout, as in *A. marshami*.

♀. Larger, more dilatate than male, the elytra broader, more ovate in outline; under surface more strongly convex; intermediate tibiae not notched. *Dimensions*: ♂. 16 × 6.5 mm.; ♀. 19 × 8.5 mm.

Hab.—N.S. Wales: Inverell.

The shape of the posterior pair of thoracic tubercles should render this species easy of recognition, these tubercles are somewhat larger, broader and more flattened in the female. The combination of comparatively short posterior tarsi with the notched intermediate tibiae should also distinguish it from its known congeners.

I have at various times seen a number of specimens of this species, all from the New England Tableland in the vicinity of Inverell.

Acantholophus echidna Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 280.

♂. In general appearance resembling *A. marshami*, but venter differently sculptured. Black, clothing scanty.

Head concave in front, intercristal ridge low; supraorbital crests larger than in *A. marshami*, the anterior ramus strongly convex anteriorly, with apex obtuse, the posterior ramus somewhat longer, directed slightly backwards. Rostrum similar to *A. marshami*, but with the external margins more strongly angulate. Antennae with first and second joints of funicle subequal; club short, hardly pedunculate. Prothorax with two anterior tubercles of submedian group separ-

ate, or conjoined to form a short ridge, the central ones somewhat exserted, the penultimate larger, obliquely set and overhanging the posterior constriction; lateral tubercles as in *A. marshami*. Elytra with a row of large granules along suture, most evident at base, granules indistinct on other interstices; with stronger tubercles than in *A. marshami*; first row with 7—8, second with 6—7, more closely placed and extending farther down declivity, third row with 4; humeral tubercle small, but distinct. Ventral segments coarsely strigose, cancellate-punctate, the intermediate segments being strigose as well as the apical. Legs simple; posterior tarsi with first joint longer and more slender than in *A. marshami*.

♀. Broader than male; prothorax with two anterior median tubercles separate, the other tubercles larger than in female of *A. marshami*; elytra with a distinct row of granules along second interstice, with tubercles smaller than in ♂, but larger than in ♀ of *A. marshami*, 8, 9, and 5 in number; ventral surface more convex. *Dimensions*: ♂. 17 × 6 mm.; ♀. 19 × 7 mm.

Hab.—N.S. Wales: Blue Mountains.

This species is not uncommon at Blackheath, but I have not seen it from elsewhere. It may be easily recognised by the sculpture of the ventral segments, which is more strigose than in any other species of the *marshami* group.

ACANTHOLOPHUS ECHINATUS.

The question of what species is to be regarded as *A. echinatus* is very much involved.

The use of the name first appears in Dejean's Catalogue, 1st ed., p. 64. I have not seen this work and know of the quotation only from later authors. The name as here used appears to be merely a *nomen nudum*, but it is placed as a synonym of *A. marshami* Kirby in Masters' Catalogue (No. 4848).

Guérin-Méneville in the Voyage de la Coquille, ii., p. 122, described a species of *Acantholophus* as *A. echinatus*, and a Sydney species has hitherto been regarded as Guérin's species, with the description of which it agrees fairly well, and Port Jackson was given as the locality by Guérin. Unfortunately I have been unable to discover the date of publication of Guérin's species. Volume ii. was published as a whole in 1838, according to the date on the introduction, though the title page bears the date 1830. It is certain that the work was first published in parts or livraisons, and Sherborne and Woodward (Ann. Mag. Nat. Hist., (7), vii., 1901, p. 391), give the date of publication of this part as 1831. This can hardly be correct, as in his remarks on the genus *Acantholophus*, Guérin quotes the date at which he was actually writing as 15 December, 1833. The species therefore could not have been published before 1834, and was possibly published later still. In 1835 Boisduval in the Voy. de l'Astrolabe, ii., p. 369, published the description of another *Acantholophus echinatus*. The description itself is useless, but at the end Boisduval stated that specimens were in the Dejean Collection and in the National Museum. The specimen in the Dejean Collection, which is now in the Brussels Museum, was examined some years ago and proved to be the same as *A. mucronatus* Macl. There is also a species labelled as the type of *A. echinatus* in the Museum d'histoire naturelle in Paris, which I have also seen and which is certainly *A. aureolus* Macl. Until recently I was under the impression that this was the type of *A. echinatus* Guérin, but unfortunately I omitted to make a copy of the labels attached to the specimen, and it is possible that it is the specimen of *A. echinatus* Boisd., stated to be in the Museum national. Against it being regarded as Guérin's species are the facts that it does not conform to

Guérin's description and that the known locality of *A. aureolus* is far removed from Port Jackson. Furthermore, none of Guérin's other species of Amycterides are at all events to be now found in the Paris Museum. On the other hand, it is rather extraordinary that Boisduval should have placed under the one species two such dissimilar insects as *A. mucronatus* and *A. aureolus*. The question of the priority of Guérin's and Boisduval's names hangs on the determination of the date of publication of *A. echinatus* Guérin. Possibly the best solution of the problem would be to accept the name as being first used by Dejean, and then to sink it as a synonym of *A. marshami* Kirby.

In the meantime, and until further information is available, I propose to regard the Sydney species as *A. echinatus* Guér., as it seems to me that no further confusion will be caused by following this course, since that insect is already labelled in most collections under this name.

It is to be noted that in Masters' Catalogue the references (No. 4838) are given to *echinatus* Guér., though in his revision (Trans. Ent. Soc. N.S. Wales, i., 1865, p. 280) Macleay quoted the species as of Boisduval, making no reference to Guérin-Méneville's use of the name.

The Sydney species is included in the tabulation given in the present paper, but I have thought it advisable not to give a lengthy description. The species is closely allied to *A. spinifer* Macl., and *A. mucronatus* Macl., differing from the former in the more elongate antennae, with elongate peduncle to club, and from the latter in its more robust form, and somewhat different supraorbital crests. The female is more produced than the male, but is not strongly mucronate as in *A. mucronatus*.

ACANTHOLOPHUS MUCRONATUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 287; *A. echinatus*, Boisd. (*nec* Guérin), Voy. de l'Astrolabe, ii., 1835, p. 371; Ferguson, Proc. Linn. Soc. N.S. Wales, xxxvi., 1911, p. 143.

An elongate species, the female with the elytra strongly produced at apex and separately mucronate.

♂. Elongate; rather densely clothed with brown subpubescence; thorax with a narrow, grey, median stripe; elytra maculate with grey.

Rostrum with lateral margins angulate in middle. Head as in *A. marshami*; supraocular crests short, rather stumpy, the rami little projecting. Antennae long and slender, the second joint of funicle noticeably longer than first, club with an elongate peduncle. Prothorax similar to *A. marshami*, the median tubercles somewhat larger, and the lateral tubercles somewhat longer. Elytra long and comparatively narrow; tubercles larger than in *A. marshami*, first row with 7, second with 6, third with 3—4 in addition to humeral tubercle which is smaller but acute. Under surface with intermediate segments rather closely set with setigerous punctures tending to become confluent, apical segment strigose. Legs rather long, simple.

♀. Head and prothorax as in ♂; elytra more obese, the apex much produced and terminating on each side of suture in a long mucronation, these latter sometimes widely separated, sometimes approximated. Venter convex, punctures smaller and less confluent. *Dimensions*: ♂. 18 × 6.5 mm.; ♀. 19 × 7.5 mm.

Hab.—N.S. Wales: Blue Mountains.

The male resembles the other members of the group, but is distinguished by

its somewhat narrower form and elongate antennae; the female is distinguished by the elytral mucronation.

This species is not uncommon at Blackheath, on the Blue Mountains.

The above description has been drawn up from specimens in my own collection. On the name label in the Macleay Museum are two females, measuring 21 × 7.5 mm., and 19 × 7 mm.; the elytral tubercles number 9, 9, 5, and 8—10, 8—9, 4—5 on the two specimens.

Some years ago I examined a specimen in the Brussels Museum collection which was labelled as being the type of *A. echinatus* Boisd.* The whole question of the use of the name *echinatus* is discussed elsewhere in this paper (*see* p. 37.)

ACANTHOLOPHUS SPINIFER Macl.

Macleay, Trans. Ent. Soc. N.S.W., i., 1865, p. 284; *A. howittii*, Macl., *Id.* p. 285.

♂. Allied to *A. marshami* Kirby, but with the posterior tarsi longer. Black; thinly clothed with minute squames, brownish along suture, greyish white on the inner side of the second and third rows of elytral tubercles.

Head concave in front, with distinct intercristal ridge; supraorbital crests stout, arising from a broad base, the anterior ramus strongly convex anteriorly, apex upwardly projecting, rather blunt, posterior ramus longer, pointing upwards and slightly backwards. Rostrum with lateral margins strongly raised and angulate in the middle. Antennae with first two joints of funicle subequal, club not pedunculate. Prothorax arranged as in *A. marshami*, the submedian tubercles larger, rounded or obtusely conical, the penultimate convergent, ridge-like; lateral tubercles as in *A. marshami*. Elytra rather strongly convex; punctures small, but evident and regular, granules not traceable except at base of suture; tubercles mostly conical and spiniform; first row with 7, the basal ones obtusely, the others acutely conical and larger, ending on edge of declivity, second row with 8, all acutely conical, the apical tubercles larger and spiniform, extending half-way down declivity; humeral tubercle about one-half the size of first of third row; third row with 4—5 acute tubercles. Ventral surface nitid, with small and obsolescent punctures, somewhat larger on apical segment, not confluent except at extreme apex. Legs simple, posterior tarsi with basal segments noticeably longer and more slender than in *A. marshami*.

♀. (*A. howittii* Macl.)—Similar but broader; supraorbital crests with the two rami hardly separated; elytra with evident rows of granules between the tubercles, the latter slightly smaller than in ♂, 6, 7, 3—4, and two small tubercles are present on second interstice; apex of elytra rather feebly mucronate. Venter convex, punctures as in male. *Dimensions*: ♂. 16 × 5 mm.; ♀. 18 × 7.5 mm.

Hab.—Victoria: Bendigo, Mordialloc.

There are 2 males on the name label of *A. spinifer* in the Macleay Museum, and two females on that of *A. howittii*. A series from Bendigo, for which I am indebted to Mr. J. E. Dixon, and a series from Mordialloc in the National Museum agree with the Macleay Museum specimens, with the exception that the tubercles are somewhat fewer in number (5—6, 6, 3—4); the Mordialloc specimens are more densely covered with brownish clothing; in some cases the tubercles alone are uncovered.

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*The specimen bore the following labels:—1. Nouv Hollande; 2. Coll. Dejean, Coll. Roelofs; 3. *echinatus* d'Urville; 4. Type; 5. *Acantholophus echinatus* D'Urville h. in Nova Hollandia d. Dr. D'Urville; 6. Type *A. echinatus*.

Besides these Victorian specimens a number of forms occur in New South Wales, which seem at least entitled to varietal rank. I have thought it best to affix names to these though the actual structural differences are slight.

A. var. FUSCOVITTATUS, n.var.

♂. Densely clothed above with depressed sub-squamose tomentum, the tubercles as well as the intervals densely clothed; on head light brown, on prothorax dark brown, obscurely vittate with grey in middle, on elytra forming a broad cinnamon brown median vitta, tubercles clothed with a similar colour, the intervals between with greyish clothing, this colour extending on to the inner surfaces of the apical tubercles of the second row; sides with dense brown clothing; under surface with depressed yellowish setae moderately closely set.

Head and rostrum as in typical specimens, the antennae with the funicular joints slightly longer. Prothorax and elytra as in type, except that tubercles are fewer in number, 5—6, 7—8, 4. Under surface more closely setigero-punctate, the setae longer and paler. *Dimensions*: ♂. 16 × 6 mm.

Hab.—N.S. Wales: Yass.

Apart from the clothing this variety hardly differs from typical specimens; the difference in the length of the joints of the funicle is only appreciable when these are examined together. The following varieties also show a similar difference from the Victorian specimens in this respect.

B. var. BLANDENSIS, n.var.

♂. Larger than var. *fuscovittatus;* clothing much denser than *A. spinifer,* brown; on elytra forming a broad brown band on each side of suture, the inner surfaces of the tubercles of the second and third rows with whitish clothing. Head, rostrum and prothorax as in typical specimens; elytra with punctures rather more evident, tubercles rather smaller, 6, 7—8, 4—5, in the three rows. Under surface with scattered setigerous punctures, the setae black.

♀. Broader and more ovate, elytral tubercles similar, 8, 8—9, 6, in number, no tubercles on second interstice; ventral surface convex. *Dimensions*: ♂. 17.5 × 6 mm.; ♀. 19.5 × 8 mm.

Hab.—N.S. Wales: Grenfell.

C. var. MONTANUS, n.var.

♂. Comparatively narrow and elongate. Moderately densely clothed on prothorax and along suture with brown, more sparsely elsewhere; some obscure white clothing along median line of prothorax and sometimes of elytra, and forming obscure maculae on elytra.

Head and rostrum much as in *spinifer* but rather less deep with lateral raised angulation of rostrum more obtuse, and anterior border of supraorbital crests less convex. Prothorax as in spinifer. Elytra elongate with more numerous and smaller tubercles; the first row with 8—9, the basal ones mere granules, second with 7—9, increasing in size from base, third with small nodule at basal angle, often conjoined with first tubercle of row, the latter followed by 4 tubercles all smaller than in *A. spinifer.*

♀. With whitish clothing on elytra more marked; generally larger, but variable in size and more ovate in outline; elytral tubercles variable in number, as a rule more numerous than in *A. spinifer,* no tubercles on second interstice; ventral surface convex. *Dimensions*: ♂. 16 × 5.5 mm.; ♀. 17 × 7.5 mm.

Hab.—N.S. Wales: Blue Mts.

I have had three specimens, taken at Blackheath, in my collection for some years, and recently Mr. H. J. Carter has supplied me with 2 ♂ and 3 ♀, taken

at Mt. Victoria (January, 1920). Two of the series (♂—Mt. Victoria, ♀—Blackheath) are much smaller than the others, measuring: ♂. 14 × 5, ♀. 15 × 6.5 mm., but do not present any other appreciable differences.

I have carefully compared my series of *A. spinifer* Macl., and the above varieties, without being able to find any differences that can be regarded as of specific value. The various forms are, nevertheless, readily distinguished by their general appearance. The number of tubercles on the elytra is too variable to be used as a distinctive feature; the average size of the tubercles is smaller in var. *montanus* than in the other forms. The clothing is variable, but var. *fuscovittatus* is more distinctively clothed than the others. There are slight differences also in the comparative lengths of the joints of the funicle; in the types the first two joints appear to be subequal, in other Victorian forms the second joint is slightly longer than the first, and in the varieties *fuscovittatus* and *montanus* it is more decidedly so, while in var. *blandensis*, the two joints are equal but are longer than in the types.

Acantholophus sordidus, n.sp.

A small species allied to *A. spinifer* Macl., but with smaller, obtuse tubercles.

♂. Moderately densely covered with obscure brownish clothing.

Rostrum as in *A. marshami*, the external margins rather obtusely angulate. Head with supraorbital crests broad at base, the free margin barely notched between the two rami, anterior border strongly convex, posterior ramus briefly pointed and projecting backwards. Antennae as in *A. spinifer*. Prothorax tuberculate as in *A. marshami*, the median tubercles slightly smaller, the two anterior conjoined. Elytra with a row of granules along suture, and another less evident, along second interstice; tubercles small, noduliform, only the posterior ones distinctly conical; first row with 7, the basal one elongate, the following 3 smaller, noduliform, the last 3 becoming progressively larger and more conical, ending at edge of declivity; second row with 7, only the last 3 conical, extending further down declivity; humeral tubercle moderately large, followed by third row with 4 tubercles, the first the largest. Under surface setigero-punctate, the punctures small, not confluent, except at apex, where they tend to become reticulate. Legs simple.

♀. Larger and broader, the elytra feebly granulate between the rows of tubercles, the latter smaller than in the male, 7, 7, 4 in number in the three rows; venter convex, setigero-punctate. *Dimensions*: ♂. 14.5 × 5 mm.; ♀. 16 × 6.5 mm.

Hab.—Victoria: Jamieson (T. G. Sloane).

The species is founded on a pair received from Mr. T. G. Sloane. It is a small dingy species without any salient characteristics. It is closely allied to *A. spinifer*, and might have been considered a variety, but the difference in the size of the tubercles and to some extent the shape of the crests lead me to regard it as worthy of specific rank.

Acantholophus subtridentatus, n.sp.

A moderately small species, without outstanding characteristics.

♂. Black; moderately densely clothed with brown depressed subpubescence.

Head deeply concave in front; intercristal ridge well marked; supraorbital crests large, broad at base, the two rami conjoined for the greater part of their length, anterior border convex, free margin with a distinct though not deep, notch anteriorly between the rami, and with a shallower indentation posteriorly,

the apex directed upwards and backwards; crests, as viewed from in front, showing considerable inclination outwards. Rostrum much as in *A. spinifer* Macl. but internal ridges slightly less convergent at base. Antennae of moderate length, comparatively stout, second joint of funicle longer than first; club rather briefly obovate. Prothorax (4 × 5 mm.) much as in *A. spinifer*, but tubercles smaller; median area with deep linear impression in centre not reaching base or apex; median tubercles with first two conjoined to form a ridge, the central ones forming a group of 3 or 4, hardly larger than granules, and a moderately large obtuse tubercle posteriorly, slightly backwardly projecting, but not forming an oblique ridge as in *A. spinifer;* lateral tubercles trianguliform, the two anterior completely conjoined, the posterior distinctly smaller. Elytra (9 × 6 mm.) with seriate punctures small and shallow, the granules inconspicuous; first row of tubercles 7—8 in number, the basal 4—5 slightly elongate, small, hardly raised, the last 2—3 conical, becoming progressively larger and more acute, ending on edge of declivity; second row with 4—6 tubercles, larger and more acute posteriorly, outwardly projecting; third row with 4 conical outwardly projecting tubercles, the humeral one distinctly smaller than the other 3. Sides with a single row of granules on each of the upper two interstices. Under surface moderately closely setigero-punctate, the setae strong, the punctures rather shallow, somewhat more rugose on apical segment. Legs simple. *Dimensions*: ♂. 14 × 6 mm.

Hab.—N.S. Wales: Walcha Road.

A very ordinary looking species of the *marshami* group, the structure of its crests showing a rather faint approach to the triramate crests of *A. tridentatus;* this is perhaps seen best when the head is viewed from in front. On one elytron the apical tubercle of the second row descends to a more posterior level than that of the first row. In the sculpture of the outer surface of the mandibles, this species agrees with *A. tridentatus* and differs widely from *A. spinifer* and its allies. In the latter this surface, external to the smooth inner margin, is strongly rugulose, the inner ridges being arranged in parallel series, and the spaces between the rugulose ridges bear long setae; in *A. subtridentatus* the surface is distinctly setigero-punctate, and the intervals between the punctures, apart from being less raised and rugose, are covered with much smaller punctures.

ACANTHOLOPHUS SCABROSUS Macleay.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 287.

♂. Allied to *A. marshami* Kirby, but readily distinguished by the tibial structure.

Clothing minute, inconspicuous, brown, changing to grey on inner surfaces of elytral tubercles.

Head and rostrum much as in *A. marshami*, the supraocular crests large, with the anterior ramus strongly convex anteriorly, pointed at apex, and the posterior ramus more strongly produced, projecting upwards; external rostral margins acutely angulate in middle. Antennae rather long, first joint of funicle shorter than second, club pedunculate. Thorax similar to *A. marshami.* Elytra with a row of graules on second interstice, as well as on first at base; tubercles rather larger than in *A. marshami*, first row with 7, the last 3 conical; second row with 7; third row with a rather large humeral tubercle followed by 4 conical ones. Under surface nitid, punctures small and discrete on intermediate segments, larger and semi-confluent or confluent on apical segment. Legs with intermediate tibiae

notched above apex; posterior tibiae lightly bisinuate, bent forwards and strongly thickened on underside at apex, the thickened portion composed, at any rate in part, of a closely-set brush of setae; viewed from behind the tibiae show a good deal of inward curvature. *Dimensions*: ♂. 16 × 6—17 × 7 mm.

Hab.—N.S. Wales: Mudgee, Portland, Boro.

This species can be readily recognised by the tibial structure of the male. I believe I have females before me, both from Boro and Portland; they lack the tibial structure and have the intermediate segments more coarsely punctured and the punctures confluent. They are practically indistinguishable from the female of *A. echidna*, and I hesitate to describe them as *A. scabrosus* ♀ on that account; the known habitat of *A. echidna* does not, however, coincide with that of *A. scabrosus*.

The description of this species has been drawn up from specimens in my own collection. I have, however, examined the types in the Australian Museum; the male corresponds with the above description while the female type agrees with the females commented upon above.

Acantholophus tridentatus Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 288.

Allied to *A. marshami* Kirby, but with supraorbital crests tridentate. Black; rather densely clothed with fine brownish subpubescence, variegated with grey on elytra.

♂. Head strongly concave in front, with intercristal ridge strongly raised; supraorbital crests large, triramate, the anterior ramus rounded, projecting forwards and downwards, the median obtusely conical, projecting upwards and forwards and the posterior longer, more acute, extending upwards and backwards, the intercristal ridge running into the middle ramus. Rostrum rather deeply concave, the external margins angulate, with a short sharp tooth. Antennae with first two joints of funicle approximately equal; club rather short, stout, not pedunculated. Prothorax comparatively narrow; submedian tubercles conical, about 7 in number, the median ones exserted, the anterior slightly cristaform; lateral tubercles rather narrowly triangular, the anterior conjoined with median at base only, the median the largest. Elytra with sutural and second interstices evidently granulate, the others more obscurely granulate; with three rows of tubercles, first row with 10—11, mostly small, noduliform, but erect, the last two or three larger and acutely tuberculiform; second row with 9, the basal 4 smaller, but erect and spiniform, the apical tubercles larger and acutely conical, reaching a lower level on declivity than first row; humeral tubercle a small conical granule; third row with 4—5 acutely conical tubercles, diminishing in size posteriorly. Venter nitid, with rather long, light yellowish-brown setae, set in rather fine punctures. Legs simple.

♀. Similar, but larger and broader; elytral tubercles smaller and more numerous, 11—13, 8—11, 5—6 in number in the different rows; venter convex. *Dimensions*: ♂. 16 × 6 mm.; ♀. 16.5 × 7 mm.

Hab.—Queensland: Cunnamulla, Victoria River.

There are two males in the Macleay Museum on the name label of this species. The description of the female is taken from specimens in my own collection from Cunnamulla, given to me by Mr. A. M. Lea.

The species may be readily recognised among its near congeners by the distinctly tridentate crests.

ACANTHOLOPHUS ALPICOLA Ferg.

Ferguson, Trans. Roy. Soc. S. Aust., xxxix., 1915, p. 71.

In the original account of this species slight differences were noted between the Mt. Baldy and Mt. Kosciusko specimens. Recently (March, 1920) I have taken specimens at Mt. Kosciusko which correspond with the Mt. Baldy form. These were taken from 4000 to 5000 ft. above sea-level. Mr. Waterhouse, a month previously, secured the typical form at the summit (7300 ft.), and I think it is likely that the original specimens were secured there also. Should subsequent investigations prove that the difference between the forms is constant and is associated with a difference of habitat, it may be necessary to separate the Victorian form subspecifically. A third form also occurs in Victoria; of this, I have seen a male taken by Mr. J. E. Dixon (Jan., 1920) and a female in the collection of the National Museum; both are labelled Victorian Alps, without precise locality. This form differs in its much smaller size, but I have been unable to find any structural differences. It may be that these differences in size are only individual variations, but the types have a distinctive appearance which marks them off from the other specimens, with the exception of the male from the summit of Mt. Kosciusko. This is due, I believe, to the elytra being longer proportionally in the types, than in the other specimens.

The following are the measurements of the specimens before me:—

Mt. Kosciusko (Types)	♂. 19 × 6.5;	♀. 19 × 7.5 mm.
Mt. Kosciusko (7000 ft.)	♂. 20 × 7	
Mt. Kosciusko (4-5000 ft.)	♂. 17 × 5.5;	♀. 19 × 7
Mt. Baldy		♀. 19 × 7
		♀. 18 × 7
Victorian Alps..	♂. 15 × 5.5;	♀. 14.5 × 6.

ACANTHOLOPHUS TASMANIENSIS Lea.

Lea, Mitt. a.d. Zool. Mus. Berlin, 1910, p. 182.

This species is closely allied to *A. alpicola* Ferg. from the higher mountain ranges of Victoria and New South Wales, but is distinguished by the more distinct tubercles on both prothorax and elytra. Lea records that the crests may occasionally be bidentate, though as a rule the fusion is complete. No other species of the genus has hitherto been recorded from Tasmania.

ACANTHOLOPHUS DIXONI Ferg.

Ferguson, Proc. Roy. Soc. Victoria, xxvii., 1915, p. 256.

The position and relationship of this species are by no means clear. Provisionally I have placed it with *A. alpicola* and *A. tasmaniensis* in my table of species, but its facies is quite unlike those species and more closely resembles that of the *adelaidae* group. It is, however, more strongly tuberculate than *adelaidae* or its allies, the supraorbital crests are single and somewhat differently set, and the ventral segments, especially the apical, are different.

Hab.—Victoria: Portland.

ACANTHOLOPHUS SQUALIDUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 285; *A. truncaticornis*, Macl., *loc. cit.*, p. 286.

♂. Small; black; clothing rather sparse, brown, sprinkled with grey on prothorax and elytral tubercles.

Head with deep depression behind intercristal ridge, the latter strongly raised; supraorbital crests subcylindrical projecting forwards and upwards, the apex almost truncate, with the posterior angle continued upwards and backwards in a short point. Rostrum widely and moderately deeply concave in front; the external margins strongly raised and convex, somewhat obtusely angulate anteriorly, sinking to base; internal ridges raised; basal foveae rather large. Antennae comparatively slender, funicle with first two joints subequal, club stout, hardly pedunculate. Prothorax considerably narrower than elytra, median area with a depression in front of middle, and with some obscure granules in centre; submedian tubercles raised, though not very large, the first produced in a short ridge, the third erect, obtusely conical, followed by two or three, more transversely arranged, the penultimate tubercle larger, projecting backwards; lateral tubercles trianguliform, the median distinctly the largest, with a smaller one conjoined anteriorly, the posterior smaller and more obtuse. Elytra more or less distinctly flattened along suture; punctures and granules fairly definite and regular; with three rows of spiniform tubercles, first row with about 8, the basal ones small and granuliform, becoming somewhat larger posteriorly, the last 3 acute conical spines; second row with 5—6 all conical tubercles, but the posterior ones larger and more acute, ending about the same level as first row; humeral tubercle moderately large conical, projecting forwards and slightly outwards; third row with 4 outwardly projecting tubercles, the first very large, the others becoming progressively smaller. Venter very feebly convex from side to side, the apical segment practically flat, without any impression, set with black decumbent setae. Legs simple.

♀. Larger and more broadly ovate; the elytra broader with a transversely wrinkled sculpture, the tubercles smaller and less acute; the venter more convex

Dimensions: ♂. 12 × 5 mm.; ♀. 14 × 6 mm.

Hab.—N.S. Wales: Merimbula, Blue Mts., Sydney, Gosford, Newcastle, Richmond River.

I have examined the types (♂. ♀.) of *A. squalidus* Macl., and compared them with the type (♂) of *A. truncaticornis* Macl., but cannot find any difference.

The species is widely distributed along the coastal districts of N.S. Wales, and is not uncommon at Blackheath on the Blue Mountains.

The species does not appear to be closely related to any other known to me; the narrow erect crests separate it from the allies of *A. marshami*, while the flat abdominal segments exclude it from the *adelaidae* group. *A. foveirostris*, with which it is associated in the table, is a very different species, the similarity in the crests having led to their present grouping.

A female taken at Berowra, near Sydney, shows a curious abnormality in the shape of a median horn or tubercle projecting from the forehead.

Acantholophus foveirostris Lea.

Lea, Mém. Soc. Entom. Belgique, xviii., 1910, p. 85.

In the shape of the prothorax this species shows an approach to *A. denticollis* Macl., to which Mr. Lea regarded it as related. I cannot, however, consider that the resemblance is any indication of its true relationship. The conspicuous intercristal ridge separating the head and rostrum, the structure of the rostrum and the prothorax produced above the head with evident ocular lobes, all point to its

being a member of the first section of the genus. I do not know of any other species to which it can be regarded as closely related.

Hab—South Australia: Kangaroo Island.

ACANTHOLOPHUS SQUAMOSUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 287; *A. sublobatus*, Macl., (*partim*) *op. cit.* 1866, p. 329.

♂. Small, elongate, elytra not greatly wider than prothorax. Black; rather scantily clothed with grey depressed subpubescence.

Head concave in front; intercristal ridge low but distinct; supraorbital crests large, the anterior end rounded, projecting downwards and forwards, the posterior pointed, projecting upwards and backwards, the free border dentate in middle, so that crest appears to comprise three lobes. Rostrum with external margins strongly raised and convex in middle, sinking down to base; internal ridges distinct; basal foveae deep, their circumference broken externally. Antennae with first joint of funicle shorter than second; club stout, hardly pedunculate. Prothorax with median area linearly impressed in mid line, with a few granules, submedian tubercles low, granuliform, not set in a straight line; lateral tubercles trianguliform, the anterior completely united to middle, the posterior somewhat smaller. Elytra with regular rows of small, distinct punctures the interstices hardly granulate, except laterally; with three rows of tubercles, first row with tubercles obsolete excepting last two, the last large and conical, situated on edge of declivity; second row with 3—4 tubercles, nodular at base, conical towards apex, not present near base, and ending anteriorly to apical tubercle of first row; humeral tubercle small, nodular, conjoined with first of third row; third row with two tubercles, the second the larger and more outwardly placed. Venter flat with scattered, long, black setae, the extreme apex somewhat depressed, and with denser and shorter setae. Intermediate tibiae without a subapical notch.

♀. Differs in its broader, more ovate elytra, rather strongly produced at apex and separately or conjointly mucronate; crest similar but anterior lobe rather shorter and more obtuse; elytra with low noduliform elevations in the basal portions of the rows of tubercles, these sometimes obsolete as in male; venter feebly convex. *Dimensions*: ♂. 11 × 3.75 mm.; ♀. 13 × 5 mm.

Hab.—Victoria: Wandin, Merriyan, Emerald, Narbethong.

Closely allied to *A. nanus* but separated by the smaller and less numerous elytral tubercles; in *A. squamosus* the apical tubercle of the first row is the largest, whereas in *A. nanus* the penultimate is the largest and the apical is at a lower level. In both species there are 4 tubercles in the second row, but in *A. nanus* the first is near the second of the third row, whereas in *A. squamosus* it is much posterior to it. The apex of the elytra in *A. nanus* is more produced, and the apices separately mucronate, with a rather deep notch between; in *A. squamosus* the notch is smaller and the apices not definitely mucronate.

ACANTHOLOPHUS NANUS, n.sp.

♂. Small, elongate. Black; densely clothed with brown subpubescence, trivittate on prothorax and transversely quadrifasciate on elytra with grey; posterior femora subannulate with grey near apex.

Head widely concave in front, with two small, rather widely separated, granules above; intercristal ridge present, low in centre; supraorbital crests large.

arising from a moderately broad base, the anterior angle projecting downwards and forwards, the posterior backwards and upwards, the free margin between almost unbroken except for a slight dentation in the middle; crests obliquely set, as viewed from in front, the upper end strongly directed outwards. Rostrum deeply excavate, sides strongly raised, almost rectangular in front, posteriorly sinking almost abruptly to base; upper surface with median groove bounded at base by slightly elevated, subparallel, internal ridges; basal foveae rather large, apparently closed. Antennae rather short, funicular joints comparatively short, the first and second subequal, club obovate, not pedunculate. Prothorax (3 × 4 mm.) with moderately well developed ocular lobes; anterior constriction well marked, not extending across median ridges; median area rather narrow, moderately deeply impressed, the median tubercles conjoined to form a ridge on either side, each ridge consisting of a moderately elevated anterior portion, merging into a somewhat confused group of three or four tubercles, more outwardly placed, followed by a short ridge hardly projecting over basal constriction, and by a small granule posterior to constriction; lateral tubercles composed of two closely united tubercles anterior to middle, and a considerably smaller, triangular one posterior to middle; sides rather coarsely punctate. Elytra (8 × 5 mm.) elongate, not greatly ampliate, base subtruncate, humeral angles marked by a very small nodule, apex separately, bluntly acuminate, leaving a moderately deep emargination; seriate punctures small, but well defined, granules obscured by clothing; with three rows of strong tubercles, first row consisting of six, small near base, becoming larger posteriorly and more acute, the last set on declivity and smaller than the penultimate; second row of four, strong, conical tubercles, more outwardly directed, the last on declivity anterior to last of first row; third row with a strong tubercle immediately behind humeral nodule, followed by a single large tubercle, more outwardly placed. Sides with rather conspicuous rows of punctures, the interstices without evident granules. Under surface flattened over metasternum and basal ventral segment, elsewhere gently transversely convex; moderately closely setigero-punctate, the setae black, depressed, the punctures coarser and more closely set on apical segment. Legs simple, intermediate tibiae not notched.

♀. Similar, more ovate; head and rostrum similar; prothorax with median area somewhat less depressed, the bordering ridges tending to resolve into their component granules; elytra (8.5 × 6.5 mm.) wider, slightly less produced apically, emargination smaller; tubercles similar but basal tubercles of first row less prominent. Ventral segments more evidently convex. *Dimensions*: ♂. 12 × 5 mm.; ♀. 12 × 6.5 mm.

Hab.—N.S. Wales: Blackheath.

Described from 4 specimens. The type male has the clothing well preserved, the others are more or less abraded and of a uniform dingy black colour. *A. nanus* comes nearest to *A. squamosus* Macl., but may be distinguished by the stronger and more numerous elytral tubercles; the other differences between the species are more fully discussed under *A. squamosus*.

Acantholophus parvulus, n.sp.

♂. Very closely allied to *A. squamosus*, but with intermediate tibiae notched near apex. Head and rostrum similar to *A. nanus*, but intercristal ridge almost obsolete, only traceable from behind, the internal rostral ridges also hardly traceable. Prothorax (3 × 4 mm.) similar, but median row of tubercles smaller, the

anterior portion forming a slight ridge as in *A. nanus*, the central consisting of a confused group of small, granuliform tubercles, the posterior of a single tubercle backwardly directed, followed by a single tubercle posterior to constriction; lateral tubercles similar. Elytra (8 × 4.5 mm.) similar to *A. nanus*, apex rounded, with a small, narrow, moderately deep emargination; all the tubercles smaller than the corresponding ones in *A. nanus*, first row with only 3 tubercles, corresponding to the three apical ones, and noticeably smaller and less elevated; second row with 4; third with 2. Under surface similar, but with longer setae. Intermediate tibiae with small, but evident subapical emargination. *Dimensions*: ♂. 12 × 4.5 mm.

Hab.—N.S. Wales: Mittagong.

I have only a single male before me; this was received some years ago from Mr. H. J. Carter, in whose collection is another specimen. Though closely allied to *A. squamosus* Macl. and *A. nanus*, the present species may be distinguished from both by the subapical emargination of the intermediate tibiae.

ACANTHOLOPHUS ADELAIDAE Waterhouse.

Waterhouse, Trans. Ent. Soc. Lond., (2), iii., 1854, p. 76; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 281; *A. angasi*, Macleay, *loc. cit.*, p. 286; *A. approximatus*, Macl., *loc. cit.*, p. 283; *A. sublobatus* Macl. (*partim*), *op. cit.*, 1866, p. 329.

♂. Rather small, comparatively narrow. Black; moderately densely clothed with brown depressed pubescence, feebly maculate with grey on elytra.

Head concave in front, with strongly raised intercristal ridge; supraorbital crests consisting of two closely conjoined portions, arising from a moderately narrow base, the anterior branch only separate at extreme apex which is directed upwards and forwards, the anterior margin not strongly convex, the posterior branch longer, pointed almost directly upwards. Rostrum rather deeply concave, the lateral margins strongly angulate in front of middle; internal ridges prominent, at first oblique, then parallel to base; basal foveae small, but distinct, closed. Antennae of moderate length, the first two joints of funicle approximately equal, club moderately long, stout, not pedunculate. Prothorax moderately wide, median area deeply impressed along median line, with a few, fine, scattered granules, similar granules present on sublateral areas; submedian tubercles erect, obtuse, moderately large, but varying in size, not set in single series, the anterior tubercles somewhat elongate and slightly cristaform, the central ones exserted, the prebasal long, projecting directly backwards over the basal constriction; lateral tubercles subtriangular, the median the largest, with a small conjoined anterior tubercle, the posterior somewhat smaller than median. Elytra with fairly evident punctures and rows of small somewhat indefinite granules; first row of tubercles about 10 in number, the basal ones small, scarcely larger than granules and often indistinct, the others becoming larger, but only the last 2 distinct, the apical decidedly the largest and acutely conical; second row with 6—7, all distinct, though small and rounded near base, the last 3 stronger and acutely conical; humeral tubercle small, noduliform; third row with 5 rather small tubercles, obtuse, hardly conical. Ventral segments clothed rather sparsely with moderately long light setae, denser at sides, arising from indistinct punctures; apical segment gently convex antero-posteriorly, with posterior face flattened and nitid. Legs simple.

♀. Resembling ♂, but more robust; crests similar but apices of rami more distinctly separate; elytra similar but broader, with smaller tubercles, the basal ones hardly distinguishable from the granules, the apical ones smaller and less acute than in the ♂. Venter convex, apical segment not as in ♂. *Dimensions:* ♂. 14 × 5 mm.; ♀. 15.5 × 6 mm.

Hab.—South Australia: Adelaide, Mt. Lofty, Kangaroo Island; Victoria: Mt. Evelyn, Bullarook, Macedon, Ararat.

I examined the type of this species when in England, and have a note that it is a large female of the common Adelaide species.

The type of *A. angasi* Macl. is a male and agrees with males of *A. adelaidae* Waterh.; the crest on one side, however, is deformed and not bilobed.

On the name label of *A. approximatus* Macl. in the Macleay Museum are two males; one of these corresponds to South Australian specimens, except that the tubercles of the second row are slightly stronger at base of elytra; the other also has the elytral tubercles, particularly the basal tubercles of the second row stronger than in *A. adelaidae;* the tubercles number 9, 7—8, 4—5, and 9, 8, 5 in the two specimens. In view of the variability in respect to size and number of tubercles so common in species of *Acantholophus,* I cannot regard these specimens as specifically distinct, and must sink *approximatus* as a synonym of *adelaidae.*

There are before me numerous specimens from Victoria which I cannot separate from South Australian specimens; it may be remarked that Victorian specimens have hitherto been regarded as *A. approximatus* and South Australian specimens as *A. adelaidae.* The series exhibits a certain amount of variation; thus specimens from Bullarook and Macedon differ in having the elytral tubercles noticeably smaller and noduliform, and in the Macedon specimens the joints of the funicle are distinctly shorter. Specimens from Mt. Evelyn agree in the size of the tubercles with specimens from South Australia. In all of these there are slight differences from South Australian specimens in the lower intercristal ridge, in the slightly more obtuse supraorbital crests, and in the slightly narrower prothorax with submedian tubercles, especially the penultimate, shorter. Other specimens from Mt. Evelyn differ in having the rami of the crests completely fused so that the crest appears single.

Specimens from Ararat are indistinguishable from South Australian specimens.

A pair (♂. ♀.) from Inglewood, Victoria, collected by Mr. J. E. Dixon, perhaps represent a variety; they differ in having the crests more distinctly biramate, the anterior branch being short and erect, and the posterior more slender and slightly recurved.

Acantholophus halmaturinus Ferg.

Ferguson, Trans. Roy. Soc. S. Aust., xxxix., 1915, p. 69.

Though closely allied to *A. adelaidae* Waterh., the differences in the supraorbital crests and the wider, noticeably granulate prothorax appear sufficient to warrant the separation of this species.

Hab.—South Australia: Kangaroo Island.

Acantholophus angusticollis Ferg.

Ferguson, Proc. Roy. Soc. Victoria, xxvii., 1915, p. 259.

This species is closely allied to *A. adelaidae* Waterh., but is of a more elongate form, with narrower prothorax and more numerous and more closely placed

elytral tubercles. The division of the supraorbital crests into two rami is hardly discernible.

Hab.—Victoria: Portland.

ACANTHOLOPHUS GRAVICOLLIS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1866, p. 329.

♂. Size moderate. Black; rather sparsely clothed with brownish subpubescence.

Head concave in front, rather densely clothed; intercristal ridge strongly developed; supraorbital crests biramate, arising from a comparatively slender stalk, the anterior branch short and rather obtuse, projecting upwards and forwards, the posterior much longer and more slender, curving upwards and somewhat backwards. Rostrum rather deeply concave, the external margins triangularly raised and strongly angulate about middle; internal ridges short, oblique, widely separated at base; basal foveae small, deep. Antennae of moderate length; second joint of funicle hardly longer than first; club moderately elongate, pedunculate. Prothorax with median area longitudinally impressed in middle, with a few rather obscure granules; submedian tubercles erect, not in straight line, the first strongly raised in a securiform crest projecting well over the head, the second erect, conical, the third and fourth somewhat more outwardly placed, erect and conical, fifth external to fourth, low and granuliform, followed by one or two granules irregularly arranged, sixth projecting backwards but smaller than in *adelaidae;* lateral tubercles subtriangular, the anterior considerably smaller than the middle to which it is joined at base, the posterior nearly as long as the middle. Elytra with rows of fairly definite punctures, transversely confluent so as to give sculpture a somewhat wrinkled appearance; granules small but evident; first row of tubercles consisting of granules in basal portion, becoming somewhat larger and noduliform about middle, and ending with 2-3 definite tubercles, the last the largest and strongly conical; second row with 8, the basal ones small and obtuse, the posterior ones larger and more conical, ending on a lower level than first row; humeral tubercle distinct, conical, outwardly projecting; third row with 5 conical tubercles becoming smaller and less acute posteriorly. Venter subnitid, with rather sparse pale setae; apical segment rather convex antero-posteriorly. Legs simple; posterior tarsi rather shorter and stouter than usual.

♀. Larger and broader. Head and rostrum similar, the external margins with a short tooth at angulation. Elytra produced at apex, and rather strongly mucronate; sculpture similar, but tubercles slightly smaller, but distinct. Venter convex. *Dimensions*: ♂. 14 × 5.5 mm.; ♀. 17 × 6.5 mm.

Hab.—South Australia: Port Lincoln.

Though closely allied to *A. adelaidae,* this species can be distinguished by the more distinctly branched supraorbital crests and by the anterior tubercle of the submedian prothoracic row being raised in a strong crest.

The following appear to represent a variety rather than a distinct species.

Var.

♂. Very similar to typical specimens, but elytral granules more distinct and tubercles smaller.

♀. Elytral granules much more evident; tubercles smaller and granuliform with the exception of apical tubercle of first row and last 3 of second, and these

noticeably smaller than in typical specimens; only first two tubercles of third row distinct. *Dimensions*: ♂. 13.5 × 5 mm.; ♀. 16.5 × 6.5 mm.

Hab.—South Australia: Wirha (Mallee District), Pinnaroo.

ACANTHOLOPHUS KREFFTI Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 288.

♂. Size moderate; densely covered with light brown subpubescence, variegate with grey.

Head deeply concave, with strongly raised intercristal ridge; supraorbital crests composed of two long, erect, spinose processes, projecting forwards and upwards, conjoined at base, the intercristal ridge running into the anterior process, the posterior situated farther outwards. Rostrum not very deeply concave above, the external margins with a strong sharp spine about middle; internal ridges raised, convergent; basal foveae rather large. Antennae with first joint of funicle longer than second; club not pedunculate. Prothorax furnished with a row of long erect spines on each side of median area; the first projecting over the head, then curved upwards, the others erect, the sub-basal the longest; lateral margins with a single, large, acute, outwardly projecting spine in middle, and a small acute spicule posteriorly. Elytra with moderately large granules, obscured by clothing, larger on second interstice and spiculiform near declivity; tubercles strongly spiniform, first row with 6, the basal ones small, but erect, and bearing long setae, the posterior two or three large and acutely spiniform; second row with 6, all acute spines, but larger posteriorly and descending to a lower level on declivity; humeral angle with a large acute spine; third row with 4 acute spines, the first much the largest, the fourth a small spicule. Venter with rather sparse black setae in middle and traces of denser yellowish subpubescence at sides. Intermediate tibiae with a rather feeble subapical notch; posterior tibiae with a strong apical process projecting forwards from anterior margin.

♀. Larger and more ovate, elytra with more numerous tubercles, second interstice with two or three acute spines in front of declivity; first row with 7 spines, only the last 3 large; second with 7; third with 4. Venter convex. Legs simple; posterior tibiae as in ♂, but process rather smaller. *Dimensions*: ♂. 14 × 5.5; ♀. 16 × 7.5 mm.

Hab.—Queensland: Peak Downs.

The above description is taken from the Macleay Museum specimens, but probably the Australian Museum specimens should be regarded as the actual types.

Apart from the following species, *A. kreffti* Macl. seems to have little relationship to other described forms. It is one of the most strongly spinose species, and in this respect resembles the western members of the genus.

ACANTHOLOPHUS DODDI, n.sp.

Closely allied to *A. kreffti* Macl., but smaller, with less acute tubercles.

♂. Small, elongate, subcylindrical. Black, more or less densely clothed with greyish subpubescence.

Rostrum rather deeply excavate anteriorly; external margins raised anteriorly into a strong, subtriangular, acute spine; internal ridges low, but distinct, basal foveae rather shallow, distinct, closed externally. Head concave in front; supraorbital crest arising by a rather narrow stalk, divided into two rami, the

anterior very short, projecting almost directly forwards, the posterior somewhat longer and curved upwards; intercristal ridge low in centre, running into base of anterior ramus. Antennae with scape stout, the funicle with joints rather short, the first and second subequal, the club rather briefly obovate. Prothorax (4 × 5 mm.) with a row of upstanding, moderately large, obtuse tubercles, in single series, on each side of median area; lateral margins with a strong spiniform tubercle anterior to middle, conjoined with a smaller tubercle anteriorly, and with a much smaller tubercle, less than half as long, posterior to middle. Elytra (9.5 × 5 mm.) subparallel on sides, rather strongly convex transversely; derm asperate, with punctures confused, often transverse, and rows of granules, rather confusedly set; with three rows of small tubercles, the basal ones small, the others becoming progressively larger and more acutely conical, also with two or three tubercles on second interstice above declivity; first row with 9 tubercles, the last 3—4 conical, ending on edge of declivity; second with 7, extending farther posteriorly, almost all conical, spiniform, though smaller anteriorly; third with a strong, conical, humeral tubercle, outwardly projecting, and 4 others all conical, becoming smaller posteriorly and continued as a row of obsolete granules. Sides with rows of rather obscure granules on interstices. Under surface flattened, set with long black setae. Intermediate tibiae with a small, narrow, pre-apical emargination; posterior tibiae with an anteriorly projecting process at apex, concave on under surface. *Dimensions*: ♂. 14 × 5 mm.

Hab.—N. Queensland (F. P. Dodd) .

I have seen but a single specimen of this species, and though not in good condition I have described it, as it is evidently distinct from *A. kreffti*, its nearest ally. From the latter it is distinguished by the smaller, less spiniform supraorbital crests, and by the smaller elytral tubercles.

I received my single specimen some years ago from Mr. Dodd, of Kuranda, and though without locality label, believe it comes from the hinterland behind Cairns, either from Mareeba or the Atherton-Herberton district.

ACANTHOLOPHUS HYSTRIX Bohem.

Bohemann, Schönh., Gen. Spec. Curc. vii., 1, 1843, p. 78; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 273.

♂. Small, ovate, strongly spinose. Black; densely clothed with small squames, whitish or rich brown; head with two narrow white lines and sprinkled with white on the sides; prothorax with a whitish median vitta, more creamy in centre, with sublateral vittae coppery-brown, sides with a white vitta above and sprinkled with white below; elytra with median vitta mostly coppery-brown, mixed with white anteriorly, the brown ending on declivity, thence sprinkled with white, with wavy vittae of coppery-brown between the rows of tubercles, with patches of white at the posterior ends of the vittae, sides with a wavy vitta of white along middle and a less distinct one along lower margin; sides of sternal segments with dense white squames above, the rest of the under surface sprinkled with white.

Head concave in front, intercristal ridge low in centre; supraorbital crests composed of two separate slender spines, the anterior directed upwards and very slightly forwards, the posterior almost directly upwards and longer than the anterior, the intercristal ridge running into the base of the anterior ramus. Rostrum hardly excavate, the lateral margins hardly raised, not angulate; internal

ridges little evident, convergent towards base. Antennae slender, first two joints of funicle subequal, club with moderately long peduncle. Eyes rounded. Prothorax with submedian row of tubercles in single series, the tubercles long, slender, erect, like a palisade, the anterior tubercle projecting overhead and upturned at apex, the second, third and fourth with a slight backward curve, the third the largest, the fifth much smaller than the others, no tubercle posterior to basal constriction, the latter ill-defined; lateral margins with a long, slender, curved spine in middle, with a small, conjoined anterior one, and a short obtuse tubercle posteriorly, its apex bent backwards. Elytra rather strongly rounded on sides, strongly convex antero-posteriorly and from side to side, strongly declivous to base of prothorax, and basal margin set with three, small, forward-projecting tubercles at the ends of the first, third and fifth interstices; the first, second, fourth and sixth interstices with rows of small but evident granules, much displaced by the tubercles on the intervening interstices; with three rows of strong spiniform tubercles, the first with 6, all upright spines, the posterior ones very long and curved; second with 4 similar to those of first row, but larger and ending on same level; humeral tubercle placed at junction of fifth, sixth and seventh interstices, in line with tubercles of second row, large and spiniform, with two small granules anterior to it; third row with two outwardly-projecting spines. Venter flat, sparsely and shallowly setigero-punctate, with whitish squames at sides of segments. Legs simple.

♀. As in ♂, but more strongly rounded on sides; venter convex and more evenly clothed with white squames. *Dimensions*: ♂. 10.5 × 5 mm.; ♀. 9.5 × 4.5 mm.

Hab.—Western Australia: King George Sound.

A second female differs in being larger, with proportionally longer elytra and more numerous tubercles,—7, 5, 5; the dimensions are 12 × 6 mm.

Though associated with *A. bivittatus* Bohem., it is not very closely allied to that species; it is closest in appearance to *A. kreffti* Macl., but it is really a species *sui generis*.

ACANTHOLOPHUS BIVITTATUS Bohem.

Bohemann, Schönh. Gen. Spec. Curc., vii. (1), 1843, p. 74; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 274.

Small, elongate. Black; sparsely clothed with dark subpubescence, with a narrow median creamy vitta, bifurcate on head and extending almost to edge of declivity; with creamy macules on elytra, on declivity between first and second rows of tubercles and towards lateral margins; sides with a white vitta extending along middle of prothorax and along lower margin of elytra.

Head concave in front with two small granules above; intercristal ridge low; supraorbital crests composed of two short stumpy processes separate practically to base, the intercristal ridge running into the anterior one. Rostrum rather deeply concave; external margins somewhat raised, obtusely angulate in front, and sinking to base; internal ridges moderately long, distinct, convergent to base. Eyes ovate. Antennae slender, first and second joints of the funicle subequal, club short, not pedunculate. Prothorax with median area moderately deeply depressed; submedian tubercles small, erect, subconical, not in a straight line, the central ones being more outwardly placed; lateral tubercles acute, subspiniform, the median the longest, the anterior half as long as median, conjoined,

the posterior small, more triangular in shape. Elytra with rather large punctures and evident granules, but structure obscured by the tubercles; sutural interstice without granules; second with a row of erect conical granules, larger posteriorly, not extending down declivity; with three rows of tubercles, first row with 5—6, the basal ones erect, conical, the rest acute and spiniform; second row with 5, all acute, but larger posteriorly and extending further down declivity than first row; humeral tubercle small, acute; third row with 2 large outwardly projecting acute tubercles. Venter nitid; gently transversely convex; with a few scattered setigerous punctures, and a small patch of white squames on each side near apex. Legs simple.

♀. Very similar; second interstice with line of granules ending above declivity in a small tubercle; venter more convex. *Dimensions*: ♂. 11 × 4 mm.; ♀. 11.5 × 4.5 mm.

Hab.—Western Australia: King George Sound.

The position of this species is doubtful, as it is not closely allied to any known to me. I have placed it among the spinose species, but the lateral prothoracic tubercles are hardly spiniform; at the same time it is not at home among the species comprising the tuberculate group. In general appearance it is not unlike a species of *Hyborrhynchus*.

ACANTHOLOPHUS TRIBULUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1866, p. 330.

♂. Small, elongate. Densely clothed with short brown subpubescence, the prothorax and base of elytra albo-vittate along middle line, and elytra maculate with white; sides of prothorax with rather sparse white clothing, and inferior border of elytra albo-vittate.

Head concave in front; intercristal ridge distinct; supraorbital crests biramate, the anterior branch projecting forwards with apex upturned, the posterior curved upwards with inclination backwards. Rostrum short, widely concave above; external margins with a short, conical tubercle in middle; internal ridges well marked, oblique, strongly convergent. Antennae slender, funicle with second joint slightly longer than first; club elongate, hardly pedunculate. Prothorax with median line impressed in posterior two-thirds; submedian tubercles moderately large obtuse nodules, not in single series, the third more outwardly placed, and a small nodule present external to the fourth; lateral tubercles subcylindrical, the median the largest, slightly recurved at apex. Elytra with rather obscure, somewhat transverse punctures; granules moderately distinct; with three rows of tubercles, the first row with 10, the basal ones small and noduliform, the others conical, becoming larger posteriorly; second row with 9, all conical, longer and more acute posteriorly, ending on a level with first row; humeral angles with moderately large conical tubercle; third row with 5—6 tubercles, conical, becoming smaller posteriorly. Venter flat, nitid, with rather long, scattered decumbent setae, mainly light-coloured. Legs simple. *Dimensions*: ♂. 12 × 4.5 mm.

Hab.—South Australia: Port Lincoln.

The above description is taken from the specimen in the Macleay Museum, but this may not be the type.

I have placed this and the following species among the spinose species, but they have no near relation to the other spinose species, and in general appearance more nearly resemble *A. adelaidae*.

ACANTHOLOPHUS SIMULATOR Ferg.

Ferguson, Trans. Roy. Soc. S. Aust., xxxix., 1915, p. 71.

I am very doubtful whether this species should be regarded as more than a variety of *A. tribulus* Macl. The supraorbital crests are, however, stouter, and the tubercle on the external rostral margins longer and more acute; the prothorax has the first tubercle of the submedian row more elongate, projecting farther over the head; the lateral tubercles are shorter and stouter. The elytral granules are also more distinct.

Hab.—South Australia: Kangaroo Island, Lucindale.

ACANTHOLOPHUS MASTERSI Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1866, p. 327; *A. posticalis*, Macl., *loc. cit.*, p. 327.

♂. Comparatively narrow, elongate, strongly convex. Somewhat sparsely covered with coppery brown, subsquamose clothing, more densely vittate with white, a central vitta extending from head to about middle of elytra, a second between first and second rows of tubercles on apical half of elytra, a third between second and third rows at base; sides albo-vittate along middle of prothorax and lower border of elytra, with some macules above on the elytra; sternal segments with depressed white subsquamose clothing, thickest at the sides.

Head comparatively narrow, convex, rather feebly impressed in front, with a deeper fovea anteriorly; intercristal ridge low, hardly traceable, supraorbital crests rather closely set, single, acute, spiniform, without any outward divergence; eyes closer together and nearer front of head than usual. Rostrum shallowly excavate, external ridges hardly raised, somewhat convergent to base; median line lightly impressed; internal ridges low; basal foveae small, rather shallow. Antennae long and slender; funicle with second joint evidently longer than first; club pedunculate. Prothorax little produced above, with ocular lobes barely traceable; submedian tubercles erect, conical or spiniform, set in single series, the median ones somewhat larger than the others; lateral margins with an acute, slender, rather strongly recurved spine in front of middle, with a small conical tubercle at base anteriorly, postero-lateral tubercle small, obtuse. Elytra strongly declivous, and with lateral margins greatly convergent at base, but without any humeral angulation; punctures shallow, and granules almost obsolescent; with three rows of strong spiniform tubercles; first row with 6, all acute spines, but middle ones rather smaller than the others, the apical spine long and acute; second row with 4 isolated, strong, acute spines; third row with 2, somewhat smaller but acute, and with a small tubercle anteriorly. Venter with punctures indistinct, with scattered, decumbent, white setae, condensed at sides to form a series of spots. Legs simple.

♀. (*A. posticalis* Macl.). Larger, with much broader and more convex elytra; more densely clothed with mingled grey and brown, rather feebly variegate with white; median line and base of elytra with a whitish vitta.

Head, rostrum and prothorax as in ♂. Elytra ovate, very strongly convex; strongly declivous at base, with shoulders rounded off; apex rather strongly mucronate; tubercles much smaller and more numerous than in ♂; first row with 10, the basal one fairly large, the others small and obtuse, becoming larger posteriorly, the apical one spiniform, though smaller than in ♂; second row with 8,

all small; third with 5, also small, the second moderately distinct, the others hardly more than nodules. Venter rather strongly convex. *Dimensions*: ♂. 14 × 5mm.; ♀. 16 × 7 mm.

Hab.—Western Australia: Stirling Ranges.

The above description is taken from the Macleay Museum specimens, of which there are 2 ♂ under *A. mastersi* and two ♀ under *A. posticalis*. It is uncertain whether these or the Australian Museum specimens are the actual types. There can be no doubt that Macleay was misled by the great difference in the sexes, in describing them as two distinct species.

ACANTHOLOPHUS GLADIATOR Pasc.

Pascoe, Journ. Linn. Soc. xii., 1873, p. 6, plate II., fig. 3-3*a*.

♂. Black; rather densely clothed with minute sandy squames, somewhat lighter on sides.

Rostrum widely and shallowly concave, lateral margins hardly raised, rectangulate anteriorly; internal ridges short, little prominent; basal foveae rather shallow, closed. Head with intercristal ridge low, V-shaped; supraorbital crests short, single, acutely pointed, set at right angles to plane of head. Antennae with first joint of funicle shorter than second; club moderately elongate. Thorax with anterior tubercles of submedian row forming a strong securiform crest projecting over head, followed by a row of 4 large conspicuous tubercles in single series; lateral tubercles comprising a large median spine and a much smaller posterior one, about half its size. Elytra with punctures obsolete, and granules small; with three rows of spiniform tubercles, first row with 5—7, anterior ones small, the apical two large and spiniform, ending at declivity; second with 4—5, all large, increasing in size to declivity, and ending half way down, with a smaller, acute, preapical tubercle or spine on either side; humeral tubercle large and spiniform; third row with two tubercles only. Ventral surface with punctures obsolete; apical segment slightly rugose at extreme apex. Intermediate tibiae with subapical notch.

♀. More robust with smaller and more numerous elytral tubercles; first row with 10 mostly small, the apical two large, acute, spines, the last one situated halfway down declivity; second row with 6, not including humeral and preapical, spiniform but shorter than in ♂; third with 2; remaining interstices with evident granules; intermediate tibiae without notch. *Dimensions*: ♂. 18 × 7 mm.; ♀. 19.5 × 8.5 mm.

Hab.—Western Australia: Mullewa, Cunderdin, Kellerberrin.

The specimen from Kellerberrin possibly represents a variety, as the apical ventral segment is set with larger and coarser punctures; Pascoe describes the abdomen as "sparse punctato," which corresponds better with the Mullewa male.

The description of the female is from a specimen taken by Mr. T. G. Sloane at Cunderdin, near Kellerberrin, and probably conspecific with the Kellerberrin male; the supraorbital crests in this specimen are minutely bifid at the extreme apex.

ACANTHOLOPHUS NIVEOVITTATUS Blackb.

Blackburn, Proc. Linn. Soc. N.S. Wales, v., 1890, p. 576.

This species appears to be fairly widespread in Western Australia, at any rate in the inland districts. There is considerable difference in size between

some of the specimens. The scape is long and relatively slender, and the first joint of the funicle approximately equal to the second. The supraorbital crests have the middle branch small and often reduced to a small spicule or even absent; the intercristal ridge curves backwards into the base of the posterior ramus, the anterior arising at a distinct angle.

Hab.—Western Australia: King George Sound, Cunderdin, Tenindewa, Cue, Mullewa, Southern Cross, Yilgarn (type locality).

ACANTHOLOPHUS FRANKLINENSIS Blackb.

Blackburn, Trans. Roy. Soc. S. Aust. 1890, p. 92.

Under this species I place specimens of a species of *Acantholophus* from Yeelanna, South Australia; the type itself I have not seen, and do not know of its whereabouts; Blackburn stated that it was in the collection of Mr. J. Anderson, of Port Lincoln.

While closely allied to *A. niveovittatus* Blackb., the species differs in having the basal tubercles of the first row smaller and closer together, there being 8—9 tubercles in the row, with only the last 3 acutely spiniform, whereas in *A. niveovittatus* there are 5—6 and the basal ones, though smaller, are conical; the granules on the other interstices are also larger. The antennae are not so slender as in *A. niveovittatus*, and the supraorbital crests have the middle branch longer and more developed.

Hab.—South Australia: Franklin Harbour, Yeelanna.

VAR. Specimens from Ankertell, Western Australia differ somewhat from the Yeelanna specimens. The clothing is lighter brown, with the pale squames a pure white, in some places with a pink tinge; the elytral tubercles are rather smaller, and more numerous in the first row (10—11); the granules, particularly on the first and second interstices, are also smaller and less prominent.

ACANTHOLOPHUS HYPOLEUCUS Bohem.

Bohemann, Schönh., Gen. Spec. Curc., vii. (1), 1843, p. 76; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 275.

♂. Black: moderately densely clothed with brown, depressed subpubescence; with white subsquamose clothing forming a median vitta from head to apex of elytra, irregularly disposed macules on elytra, and an interrupted vitta along lateral margin of disc of elytra; sides of prothorax and a broad vitta along the inferior margin of sides of elytra also clothed with white; under surface and legs with longer white subpubescence more sparsely disposed.

Head rather shallowly excavate in front; intercristal ridge low; supraorbital crests composed of two slender, curved rami, distinct almost to base, the anterior curved forwards and upwards, the posterior upwards with a slight inclination backwards. Rostrum shallowly concave, almost flat above, with a somewhat indistinct median carina; lateral margins with a conical tubercle in middle; internal ridges hardly raised, widely separated at base; basal foveae distinct, closed. Antennae long and slender, first joint of funicle about equal to second, club with a moderately long peduncle. Prothorax with submedian tubercles in single series, erect, spiniform, slightly decreasing in size posteriorly; lateral tubercles spiniform, the middle one long, curved slightly back at apex, conjoined anteriorly with a smaller spine, the posterior spine well developed and acute, but distinctly

smaller than median one. Elytra with small but evident granules, and with three rows of tubercles; first row with 8, the basal 5 small, rounded, the last 2—3 larger and acutely spiniform; second row with 6, all spiniform but larger posteriorly; humeral tubercle large and conical, with a much smaller granule anterior to it; third row with 3 large acute spines, the first the longest; a pair of acute subapical spines also present. Ventral surface with somewhat sparse, white, depressed, subsetose pubescence, mixed with some darker setae, arising from shallow punctures. Legs simple.

♀. Similar, but broader in the body; ventral surface convex. *Dimensions*: ♂. 15 × 5 mm.; ♀. 16 × 7 mm.

Hab.—Western Australia: King George Sound, Esperance.

In general appearance resembling a slighter form of *A. niveovittatus*, the present species may be distinguished by the more slender, biramate, supraorbital crests. From *A. crassidens* it may be separated by the different crests and distinct, subapical, elytral spines.

ACANTHOLOPHUS CRASSIDENS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 276.

♂. Moderately large; black, with very minute scanty brownish clothing and with whitish subsquamose pubescence, forming interrupted vittae along median line of prothorax and elytra, along lateral margins of elytra, and on sides of prothorax and along inferior border of sides of elytra.

Head concave in front, with strongly raised intercristal ridge; supraorbital crests large, biramate, the intercristal ridge running into the base of the posterior branch which is stout at base and tapers to a fine point, curving outwards and upwards with a slight inclination backwards, the anterior branch much shorter and blunter, projecting forwards with the apex briefly upturned, crests, as viewed from in front, strongly outwardly divergent. Rostrum rather deeply concave above, with a narrow median carina in depth; lateral margins with a strong conical tubercle about middle; internal ridges little distinct, rather widely separated at base. Antennae long and slender, first joint of funicle shorter than second, club with rather long peduncle. Prothorax with submedian row of tubercles in single series, approximately equal in size, the first stouter but not longer than the others, all erect, but rather obtuse, an additional small tubercle present external to the fourth in the row; lateral tubercles much as in *A. hypoleucus*, but somewhat shorter and less acute, the median one acutely spiniform and rather strongly curved backwards, with a small one conjoined anteriorly, and the posterior shorter and blunter than the median. Elytra broader and flatter than in *A. hypoleucus*, with three rows of spiniform tubercles, the first row with 6, the basal ones smaller and rounded, the apical one large and acute; second row with 6, all acute, but the posterior ones larger and more spiniform; humeral tubercle large and conical; third row with 3 large spiniform tubercles, outwardly projecting, the first the largest; also with a pair of small, spiculiform, subapical tubercles, sometimes with a row of spicules extending up declivity to last tubercle of third row. Venter with clothing and punctures as in *A. hypoleucus*. Legs simple.

♀. Similar, more robust and convex on ventral surface. *Dimensions*: ♂. 16 × 6 mm.; ♀. 17 × 7.5 mm.

Hab.—Western Australia: King George Sound.

Another male labelled Albany (practically the same locality), differs somewhat in the crests, in the antennae having the first joint of the funicle rather longer and not much shorter than the second, and in the larger granules and more numerous tubercles on the elytra; the latter number 9—10, 6—8 and 3—4 in the three rows.

The species is allied to both *A. hypoleucus* Boh. and *A. niveovittatus* Blackb. From the former it may be distinguished by its larger size and stouter supraorbital crests, from the latter by the biramate, not triramate crests, less convex elytra and much smaller subapical spines.

In the Macleay Museum there are two males on the name label of this species. The elytral tubercles number 7—9, 5 and 3.

ACANTHOLOPHUS SUTURALIS Bohem.

Bohemann, Schönh., Gen. Spec. Curc., vii. (1), 1843, p. 72; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 277.

Head concave in front; intercristal ridge not very distinct; supraorbital of a metallic coppery colour; median line of prothorax with a somewhat indefinite whitish vitta; elytra with a longitudinal white spot at base and another anterior to middle on suture, sides of prothorax and lower border of elytra vittate with white, the latter vitta not reaching base of elytra.

Head concave in front; intercristal ridge not very distinct; supraorbital crests biramate, the anterior branch short, rather stout, truncate at apex, projecting forwards, posterior branch nearly twice as long as anterior, and more slender, running upwards with a slight backward curve. Rostrum rather deeply and widely concave, the lateral margins raised, rectangulate anteriorly, without a definite tubercle; internal ridges little raised, very oblique, convergent to base; basal foveae distinct. Antennae long, rather slender, first joint of funicle shorter than second, club with a moderately long peduncle. Prothorax with median lobe well produced; submedian tubercles irregularly set, the apical tubercle larger than the rest, subcristaform, second small, conical, third larger, erect, subconical, fourth and fifth small, granuliform, transversely placed, sixth larger, obtuse, projecting somewhat backwards, basal tubercle smaller, erect; lateral margins with a strong median spine, projecting outwards and curving strongly backwards, conjoined anteriorly with a smaller tubercle, posterior tubercle absent, the lateral margins indistinctly ridged and convergent towards base. Elytra with rows of distinct granules, those on first interstice large at base becoming smaller posteriorly and practically lost on the declivity; first row of tubercles 8 in number, small, obtuse but distinct, the basal one rather larger and the apical two large and spiniform; second row with 5—6 conical tubercles, the apical 3 about twice as large as the basal ones and spiniform, also with one or two much smaller tubercles immediately behind humeral tubercle; humeral tubercle moderately large and spiniform; third row with 4 acute tubercles, the first slightly the largest. Ventral segments strigose, reticulate-punctate, the sculpture obsolete on first visible segment and less marked on second. Legs with strong subapical notch on intermediate tibiae; posterior tarsi comparatively short and broad.

♀. As in male, but larger and more robust; prothorax with apical tubercle of submedian row larger and spiniform, the apex curved backwards; elytra with tubercles more numerous, first row with 10, the last 3 spiniform, second with 7 and 1 smaller one at base, third with 4, the last considerably smaller. Venter

convex, punctures subobsolete, better marked on apical segment; legs simple, *Dimensions*: ♂. 18 × 6.5 mm.; ♀. 21 × 9 mm.

Hab.—Western Australia: Perth, Swan River, Guildford, Harvey.

A large species readily recognised by the first tubercle of the prothoracic submedian rows being larger than the others. This character is also found in *A. lateralis* Bohem., to which *A. suturalis* is closely allied; the distinctive characters separating the two species are given under *A. lateralis*.

ACANTHOLOPHUS LATERALIS Bohem.

Bohemann, Schönh., Gen. Spec. Curc. vii. (1), 1843, p. 75; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 277; *A. spinosus*, Macleay, *loc. cit.*, p. 274.

Close to *A. suturalis* Bohem., but shorter and relatively stouter. Black; with brown subsquamose clothing, vittate with white or cream, a median vitta extending from head to edge of declivity of elytra, a short vitta down declivity between first and second rows of tubercles, and a vitta at base of elytra between second and third rows; sides with a prominent white vitta along middle of prothorax, and lower margin of elytra.

Head, rostrum, antennae and prothorax as in *A. suturalis*. Elytra shorter, oval in shape; granules not conspicuous except for a row of large granules along each side of suture; tubercles fewer in number and farther apart, first row with 6, the basal 4 obtuse but decidedly larger than in *A. suturalis*, the basal tubercle being larger than the others, the apical two, strong, acute spines; second row with 5 all large and distinct, but the basal 2 smaller and less acute than the others; humeral angle with 2 obliquely set, rather small, tubercles; third row with 2—3 large spiniform tubercles.

♂. Venter strigosely reticulo-punctate as in *A. suturalis*; intermediate tibiae notched.

♀. Venter convex, sculpture obsolete; intermediate tibiae only shallowly notched. *Dimensions*: ♂. 16 × 6.5 mm.; ♀. 16 × 6.5 mm.

Hab.—Western Australia: Swan River, King George Sound.

Bohemann's lengthy description leaves no doubt as to the identity of his species, and I can find no reason for separating *A. spinosus* Macl. from it, though Macleay placed the two species in different groups. In commenting on this species and *A. suturalis*, Waterhouse stated that *A. lateralis* had a single large humeral spine, whilst *A. suturalis* had two or three very small spines on the humeral angle of the elytra. Macleay remarked that he could find no such distinctive marks. From the short series of *A. lateralis* (4) and *A. suturalis* (6) before me I should say that the reverse was the case, but probably it is a variable character as one of the specimens of *A. suturalis* has two small tubercles in place of a single one.

The species is evidently very close to *A. suturalis*, but apart from the clothing may be distinguished by its shorter form and the fewer elytral tubercles, especially in the first and third rows. In *A. lateralis* there never appear to be more than 3, generally 2, tubercles in the third row, while in *A. suturalis* there are 4 and sometimes more on this row.

ACANTHOLOPHUS HUMERALIS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 278.

♂. Large, rather strongly convex from side to side. Black, tubercles slightly reddish; densely clothed with brown decumbent pubescence, vittate with

white, a median vitta not extending down declivity, interrupted vittae between the rows of tubercles; sides of prothorax vittate above, sides of elytra maculate with white.

Head concave in front; intercristal ridge strongly raised; supraorbital crests biramate, the posterior ramus long, curving upwards and somewhat backwards, slender and acutely pointed at apex, the anterior ramus much shorter, slender and pointed, the apex directed upwards and forwards arising in front of junction of intercristal ridge with crest. Rostrum concave above, with a rather deep, median, foveiform depression anteriorly; lateral margins raised in an obtusely conical tubercle about middle; internal ridges low, convergent; basal foveae small. Antennae with scape somewhat flattened; funicle with first joint slightly smaller than second; club briefly pedunculate. Prothorax with median area rather deeply longitudinally impressed anteriorly, more lightly posteriorly; submedian tubercles in single series, erect, conical, the two anterior somewhat recurved, but not larger than the others, the two median the largest and somewhat more outwardly placed; lateral tubercles spiniform, the median large, acutely pointed and somewhat recurved, the anterior and posterior hardly more than spicules. Elytra elongate, subparallel, rather strongly convex transversely, punctures and granules obscured by clothing and tubercles; with three rows of strong spiniform tubercles, first row with 7, the basal ones smaller, but stout and subconical, the apical 2—3 larger and acutely spiniform; second row with 8 strong spines, larger and more acute posteriorly, extending farther down declivity than first row; humeral tubercle a large strongly recurved, outwardly projecting spine; third row with 3—4 strong spines. Ventral surface set with large, longitudinally confluent punctures, the intervals strongly raised and strigiform, more reticulate on apical segment. Intermediate tibiae with a strong subapical notch; posterior tibiae bisinuate, with a strong spur-like process projecting anteriorly at apex, somewhat recurved and bidentate. *Dimensions*: ♂. 20 × 7 mm.; ♀. 21 × 9 mm.

Hab.—Western Australia: Beverley, Ankertell.

This species cannot well be confused with any other described species; it appears to be most nearly related to *A. spinosus* Macl. and *A. suturalis* Bohem. but may be readily distinguished by the first tubercle of the submedian prothoracic row not being larger than the other tubercles of the row.

The female differs from the male in being more obese, with the elytral tubercles 6—7, 6—7, 4 in number; the venter is convex, with obsolete punctures, and the middle tibiae are not notched.

The species presents some variation in form and in the size of the tubercles. A male from Beverley is more convex and has the tubercles distinctly reddish, while the tubercle on the external rostral margin is an acute spine. Specimens from Ankertell are flatter, much less convex than the Beverley specimen, the elytral interstices are broader and the tubercles rather smaller, 7—8, 8, and 4 in the three rows, the external rostral margins are angulate but not definitely tuberculate. The female from Ankertell has a short tubercle on the rostral margins; the elytral granules are more distinct and the tubercles rather smaller, 9, 9, 4 in number. The actual types which are in the Macleay Museum are intermediate between the two extremes shown by the Beverley and Ankertell specimens.

In addition to these Western Australian specimens I have before me specimens of a form from the Mallee District, Victoria, which I am unable to separate specifically from *A. humeralis*. In view of the apparent disconnected distribution I have thought it advisable to give a varietal name to these specimens.

Var. ORIENTALIS, n.var.—♂. Smaller; clothing darker, with white vittae and macules less marked. Rostrum with a small tubercle on external margins, head and prothorax otherwise as in specimens from Ankertell; antennae with moderately long peduncle to club. Elytra with evident granules between the rows of tubercles; the tubercles smaller than in typical specimens, 8, 9, and 4 in number. Venter and legs as in typical specimens. *Dimensions*: ♂. 17 × 6.5 mm.

Hab.—Victoria: Mallee District, Lake Hattah.

ACANTHOLOPHUS CUPREOMICANS, n.sp.

♂. Large, robust, closely allied to *A. humeralis* Macl. Black; densely clothed with short subsquamose pubescence of a coppery colour with metallic lustre, the clothing sparser on prothorax; sides maculate with white, on prothorax beneath expanded margin of disc, on elytra irregularly disposed.

Head concave in front, intercristal ridge definite, moderately low in centre; supraorbital crests stouter than in *A. humeralis*, especially the anterior ramus which projects strongly forwards at base. Rostrum somewhat shorter than in *A. humeralis*, external margins raised in a strong, conical, pointed tubercle; internal ridges low, basal foveae distinct. Antennae as in *A. humeralis*. Prothorax rather strongly produced in front; median area rather wide, parallel sided, median line lightly impressed; submedian tubercles in single series, shorter than in *A. humeralis*, subequal and set in straight line, except the basal pair which are smaller and closer together, apical tubercles somewhat cristaform; lateral margins with a long acute spine in front of middle, with a smaller one conjoined anteriorly, and two small dentiform tubercles posteriorly in the position of the posterior lateral tubercle. Elytra almost parallel-sided, less convex than in *A. humeralis*; punctures rather obscure, granules small but fairly regular; with three rows of tubercles, first with 9—10, mostly small or granuliform, the last 2 larger acute spines; second with 7—8, all acute, but the last 4 larger, slender acute spines, ending posteriorly to the tubercles of first row; humeral tubercle single, large and acute; third row with 4, all acute but decreasing in size posteriorly. Venter flattened, with large longitudinally confluent punctures, the intervals raised and strigose. Intermediate tibiae with subapical emargination, not quite as deep as in *A. humeralis*, posterior tibiae similar to *A. humeralis*.

♀. Larger, with broader elytra; clothing similar but side spots bluish; elytral tubercles smaller, 10, 8 and 4 in number; venter convex, with sculpture subobsolete. *Dimensions*: ♂. 17.5 × 7 mm.; ♀. 19 × 8.5 mm.

Hab.—Western Australia: Mt. Barker, Parkerville. Described from 4 specimens, two males in the collection of the Australian Museum, and two females received from Mr. J. Clark, from Parkerville.

Closely allied to *A. humeralis* Macl., the present species, apart from clothing, differs in the stouter supraorbital crests, in the shorter rostrum with larger marginal tubercles, in the wider, parallel-sided median area of the prothorax and in the shorter elytral tubercles. The contrast in the clothing of this species as compared with that of *A. humeralis* is most marked.

Holotype male in Australian Museum, allotype female in Coll. Ferguson, paratype female in Coll. Clark.

ACANTHOLOPHUS OCELLIGER, n.sp.

♂. Size moderately large, flattened above. Densely clothed with dark brown subsetose clothing; prothorax with lateral areas clothed with cinnamon-

brown; elytra with a large round spot of cinnamon-brown on each side about the middle, and another on each side of declivity on apical tubercles of second row; sides of prothorax with a vitta of creamy squames above legs, elytra with interrupted patches of the same colour along lower border.

Head strongly concave in front, the intercristal ridge low in centre; supra-orbital crests large, broad at the base, the anterior ramus projecting forwards, the posterior and longer upwards and backwards, the crests as viewed from in front projecting strongly outwards. Rostrum rather deeply concave in front, the oblique internal ridges not conspicuous, convergent to base, but not meeting; basal foveae small, distinct; lateral margins raised about middle into a strongly projecting triangular tubercle. Antennae of moderate length and stoutness, club elongate obovate, not with a slender peduncle. Prothorax (4.5—5 × 5.5—6 mm.) moderately broad, ocular lobes present, not prominent; median area rather broad, the median tubercles of moderate size, the first slightly elongate, the second smaller, more rounded, the remainder, forming a row from a slightly more outward position obliquely inward towards base, conical, separate tubercles. Lateral margins with a large, strongly projecting, median tubercle conjoined and almost fused with a smaller anterior one, and with a much smaller triangular tubercle, posterior to middle constriction. Elytra (10—12 × 6—7 mm), rather flattened above, base truncate, humeral angles with a strong, outwardly projecting tubercle; punctures small, obscure, granules obscured by clothing; first row of tubercles comprising two to three small, hardly traceable tubercles and two much larger posterior ones, the last one the largest, spiniform, strongly projecting backwards and situated above summit of declivity; second row of four or five tubercles, the basal one small, the others strong, conical, outwardly projecting, the last situated on declivity, posteriorly to apical tubercle of first row; third row consisting of humeral and two other strong conical tubercles. Under surface with scattered setigerous punctures, closer and coarser on apical segment. Legs simple. *Dimensions*: ♂. 16—18 × 6—7 mm.

Hab.—Western Australia.

Described from four specimens, type in National Museum, Melbourne.

This species does not resemble any other species of *Acantholophus* with which I am acquainted, and its position in the Table is only tentative, it might with almost equal propriety have been placed among the tuberculate rather than the spinose species.

ACANTHOLOPHUS TATEI Blackb.

Blackburn, Report Horn Exped., 1896, p. 292.

During a recent short residence in London, I was able to examine the type of *A. tatei* Blackb., and to compare it with a cotype (♀) of *A. tennantensis* Ferg. Apart from some difference in the shape and development of the supra-orbital crests, the two species are absolutely identical. The differences as noted below are, however, quite evident when comparing the crests of the two forms, and there are at least two other forms before me which show other differences mainly in the crests. While giving names to these different forms, I would regard them in the light of varieties or geographical races rather than as distinct species.

All the various forms agree in the slight excavation of the dorsal surface of the rostrum, in the tubercles of the median prothoracic rows being conical and set in single series, in having the two anterior lateral tubercles more or less conjoin-

ed, the hinder of the two long and spiniform, in the reduction of the posterior lateral tubercle to a short conical spicule or granule, and in the small degree of development of the elytral spines.

A. TATEI Blackb.—Rostrum with lateral margins raised in a slight angle anteriorly; supraorbital crests strongly developed, the anterior ramus projecting forwards and suddenly turned up at apex, the posterior projecting upwards and backwards, then suddenly bent backwards to apex.

Hab.—Central Australia: Charlotte Waters.

Var. TENNANTENSIS Ferg.—Rostrum as in *tatei;* supraorbital crests shorter, the rami short and rather stumpy, the posterior somewhat the longer, not suddenly bent backwards at apex.

Hab.—Central Australia: Tennants Creek; N. Territory: Alexandra.

Var. MURCHISONI, n.var.—Larger than *A. tatei*, rostrum slightly longer, external margins not raised, and very obtusely angulate; crests well developed, the rami strong, the posterior much the longer, evenly curved upwards and backwards to apex. Antennae with first joint of funicle longer than second, all joints, noticeably the first and second, longer than corresponding joints in *tennantensis*. Elytra more elongate, but sculpture as in *tennantensis*. *Dimensions*: ♂. 17 × 7 mm.; ♀. 18 × 8 mm.

Hab.—Western Australia: Ankertell (H. W. Brown).

This form might perhaps be granted specific rank, on account of the differences in the rostrum and antennae.

All the above forms have very similar clothing; the upper surface is densely covered with sandy or yellowish-brown, narrow, decumbent subpubescence, with traces of white vittae on prothorax and maculae on elytra; the sides of prothorax and lower margins of sides of elytra are densely clothed with white flattened squames.

Var. ARUNTARUM, n.var.—♂. more sparsely clothed with shorter pubescence, more evidently maculate with white on elytra and sides.

Rostrum rather deeply excavate above, the sides raised anteriorly into an acute angle. Supraorbital crests similar to *murchisoni*, but smaller and more slender. Antennae with first two joints of funicle longer than in *tennantensis*, but shorter than in *murchisoni*, the whole antenna rather more slender. Elytra with spines rather larger and more closely set.

♀. Differs also from ♀ of *tennantensis* and *murchisoni* in having no tubercles on the second interstice. *Dimensions*: ♂. 14.5 × 5.5 mm.; ♀. 16 × 7 mm.

Hab.—Central Australia: Alice Springs.

Types in National Museum, Melbourne.

This form should also perhaps be given specific rank, but it cannot be regarded as conspecific with *murchisoni* except by regarding both as varieties of *tatei*. The difference in the rostrum is alone sufficient to distinguish them; the supraorbital crests in *aruntarum* show much less outward inclination, when viewed from in front, than they do in *murchisoni*.

ACANTHOLOPHUS TRAGOCEPHALUS, n.sp.

♂. Small, elongate, narrow. Black; densely clothed with cinnamon brown subpubescence, with a narrow median vitta and interrupted vittae along the inner sides of the rows of tubercles on the elytra of a lighter colour; sides of prothorax and lower border of sides of elytra with white squames; ventral surface with sandy, almost golden, squames, thickly but somewhat irregularly disposed.

Rostrum short, shallowly concave above in front, external margins feebly angulate anteriorly; oblique internal ridges united to form a median carina, running up on to intercristal ridge. Head concave behind crests; supraocular crests single, strong, projecting upwards and arched somewhat backwards to apex, the two crests almost joined at base, as viewed from in front, without much outward inclination. Antennae with scape long, slightly curved, moderately stout and of uniform thickness; funicle with first two joints subequal, of moderate length; club not pedunculate. Prothorax (3 × 4 mm.) much as in *A. tatei;* anterior margin slightly produced above, with moderately distinct ocular lobes; median line deeply impressed; with a row of tubercles on each side of median area, prominent, spiniform, about 6 in number, arranged in single series, the two rows slightly farther apart in middle than at apex or base, apical two tubercles smaller and conjoined at base; lateral margins with a large, acute, outwardly projecting spine, with the apex slightly curved backwards in front of middle, a small conjoined spine at the base of this anteriorly, and a small dentiform tubercle posterior to middle. Elytra (8.5 × 5 mm.) gently rounded on sides; punctures shallow, obscured by clothing, with rows of little evident granules on the interstices between the three rows of tubercles; first row of tubercles with 12, the basal ones small and mere granules, the last 3—4 becoming larger and spiniform, one or two granules present on declivity; second row with 10, the basal 7 small, but conical, the last 3—4 acutely spiniform, reaching a more posterior level than first row; third row with large humeral and subhumeral spines, the latter the larger; followed by 3 much smaller spines, the row degenerating into mere granules. Under surface with punctures obscured by clothing, the last segment apparently rugosely punctured. Legs simple. *Dimensions*: ♂. 13 × 5 mm.

Hab.—Western Australia: Onslow.

Apart from the single crests, this species differs from *A. tatei* and its variations in its smaller size and smaller elytral tubercles. Two specimens from Onslow and Ashburton R., in the National Museum, may represent a variety: they differ in having the anterior ramus of the supraorbital crests represented by a short spicule, the crests are also not conjoined at base; the ventral surface is destitute of clothing, and the punctures are obsolete and only rugose at extreme apex. Another specimen (♂) from Cue, has the anterior ramus present, but arising rather nearer the base, and the crest as a whole rather shorter and stouter; the ventral surface has the apical segment strongly strigose.

The material available is not enough to decide whether these specimens represent different species, varieties or merely individual variations.

A specimen from Middalya, in the National Museum, possibly represents a different species. It is a ♂, and has the supraorbital crests single and conjoined at base, but differs in its darker clothing, maculate with white and in the evidently larger elytral tubercles.

ACANTHOLOPHUS SIMPLEX Pasc.

Pascoe, Journ. Linn. Soc., Zool., xii., 1873, p. 7.

While in London the type of this species was examined, and the following notes made.

♂. Head spines (*i.e.*, supraorbital crests), widely separated at base, single, short, acute, a slight indication of anterior branch right at base. Prothoracic spines small, abraded, granuliform, not in a straight line; lateral spine small, but acute, posterior lateral spine almost obsolete. Elytra with rows of granules and a few

small spines about declivity on third and fifth interstices and one or two about shoulder. *Intermediate tibiae notched.*

Hab.—Western Australia: Nicoll Bay.

In my collection are two females which have been compared with the type, on which a more detailed description has been based.

♀. Moderately densely clothed with small sandy squames, maculate on elytra with larger white squames and with white vittae along inner sides of the second and third rows of tubercles; sides extensively clothed with white squames and vittate along lower border. Rostrum shallowly excavate, sides obtusely angulate in front. Head with raised intercristal ridge, supraorbital crests widely separated, consisting of a single, upward, and slightly backwardly directed spine with a short, spicule-like, anterior ramus. Antennae with first joint of funicle longer than second, and both rather short. Prothorax with the median tubercles on each side small, hardly conical, not in a straight line, the central ones more outwardly placed; median area raised with a few scattered granules; lateral margins with a spiniform tubercle in front of middle, with a small one at base, anteriorly; posterior lateral tubercle reduced to a small granule. Elytra with tubercles much reduced in size, on greater portion of interstices mere granules, hardly distinguishable from the granules of the other alternate interstices; first row with only 2—3 spines posteriorly, the penultimate the largest; second row with 4 posteriorly; third with small humeral and smaller infrahumeral tubercles, the rest mere granules. Venter rather densely clothed with yellow decumbent setae, and with white squames at sides, apical segment not strigose. *Dimensions*: ♀. 15 × 6 mm.

Hab.—Western Australia: Condon (H. M. Giles).

This species can be readily separated from its congeners, *A. tragocephalus* and allies, by the prothoracic tubercles being smaller and the central ones more outwardly placed. According to my notes, the male has the middle tibiae notched subapically, though the other species of the *tatei* group have the tibiae simple.

ACANTHOLOPHUS AUREOLUS Bohem.

Bohemann, Schönh. Gen. Spec. Curc., vii. (1), 1843, p. 79; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 272; *A. rugiceps*, Macl., *op. cit.*, 1866, p. 328.

♂. Rather small; black, more or less densely clothed with brown subpubescence, maculate with grey.

Head concave in front, obliquely and rather indistinctly longitudinally rugose, with two obscure granules, sometimes absent, about middle; head separated from rostrum above by a transverse groove; supraorbital crests single, projecting upwards and pointed at apex. Rostrum concave above, with a distinct median carina; external margins moderately raised, with a distinct tubercle anteriorly; internal ridges slightly raised. Antennae with scape distinctly curved, somewhat bisinuate; funicle with second joint much longer than first; club elongate, pedunculate. Prothorax flattened or feebly concave; anterior margin subtruncate, not produced over head, ocular lobes absent; disc closely set with granules, the submedian tubercles hardly distinct from the granules; lateral tubercles strong, trianguliform, the median the largest, the anterior tubercle somewhat smaller, conjoined with median at base, the posterior tubercle smaller than median, acute, with a small tubercle at base anteriorly, and a granule posteriorly. Elytra emarginate and separately mucronate at apex; with rows of evident punctures and

moderately distinct granules; suture with a pair of small, closely placed spicules below summit of posterior declivity; three rows of acute spiniform tubercles, first row about 8, the basal ones small and noduliform, the last two acute and spiniform; second row 6—7, strong spiniform tubercles, extending almost to base and reaching a lower level on declivity than first row; humeral tubercle small, but distinct; third row represented by a single large tubercle followed by a row of 3—4 granules. Venter moderately closely set with rather long, decumbent, yellow setae. Legs simple.

♀. Similar, but larger and broader, more produced at apex and strongly mucronate. Head with rugae more marked, separated by deep impressions. Prothorax similar. Elytra with granules more distinct; tubercles smaller, first row with granules on basal portion, not distinct from granules of disc, the last 3—4 distinct tubercles, becoming progressively larger; second with 7 distinct spines; humeral angle with a row of 3 tubercles; the posterior the largest and in line with second row. Venter convex. *Dimensions*: ♂. 14 × 5 mm.; ♀. 17 × 7 mm.

Hab.—Western Australia: King George Sound.

I do not think that there can be any doubt that the present species is *A. aureolus* Bohem., under which name it has long been known in Australian collections. But it is by no means certain that it should not bear the name *A. echinatus*. A specimen in the Museum d' Histoire Naturelle, Paris, is labelled as being the type of *A. echinatus*. The question as to the author of this species and as to the validity of the name as applied to the present species is discussed elsewhere. Until further information is available I prefer to retain the well known name of *A. aureolus*.

The specimens of *A. rugiceps* Macl., which are in the Australian Museum certainly belong to the same species.

With the exception of *A. nasicornis* Pasc., which I regard as a variety, the present species can hardly be confused with any known form. In his grouping of the genus Macleay placed *aureolus* and *rugiceps* in his first section and second group along with 4 other species all differing widely *inter se*, and with none of which *A. aureolus* has much in common. It appears to be most nearly related to *A. crenaticollis* Macl., but besides the marked differences in the supraorbital crests, that species lacks the strong, spiniform, elytral tubercles.

A male from Esperance in my collection differs somewhat from the description given above, which is founded on specimens from King George Sound.

The median dorsal line of the rostrum is impressed, not carinate; the prothorax is more distinctly concave; the elytra lack the small conjoined spicules on the suture, and the venter is somewhat sparsely clothed with white subsquamose setae. The differences hardly seem sufficient to warrant giving even a varietal name to the specimen.

Var. NASICORNIS Pasc. Journ. Linn. Soc., Zool., xii., 1873, p. 6.

♀. Closely related to *A. aureolus* Bohem., but larger.

Head similar; supraorbital crests double, the anterior portion closely applied to posterior, varying in length, sometimes appearing as a short spicule at base, sometimes as long as posterior portion, the two only being separate at apex; transverse sulcus between head and rostrum continued up on inner side of crest between the two portions. Prothorax similar. Elytra without the conjoined sutural spicules on declivity; tubercles more numerous, about 10 in number on second row. Venter with white subsquamose clothing, sparse in middle, denser at sides and apex. *Dimensions*: ♀. 18 × 7 mm.

Hab.—Western Australia: Geraldton.

I have examined the type of *A. nasicornis,* which is a female, and have 3 ♀ in my possession, one of which was compared with the type; the other two are from Geraldton and were kindly given me by Mr. J. Clark.

I can only regard *A. nasicornis* as a variety or geographical race of *A. aureolus* Bohem.; possibly, however, the males may prove more distinct.

ACANTHOLOPHUS CRENATICOLLIS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 289; *A. irroratus,* Macl., *op. cit.,* p. 328, (1866).

♂. Size moderate; black, rather densely clothed with brown subsquamose clothing, variegated with grey.

Head concave above, with a pair of small granules about middle; separated from rostrum by a transverse groove, running on to inner surface of crests; the latter broad, tridentate, the anterior lobe strongly convex anteriorly, only separated from median by a slight indentation, often absent, at apex, the median separated from posterior by a deeper notch, the latter longer and more slender, slightly recurved. Rostrum broadly concave above, lightly impressed in median line; external margins with a single acute tubercle projecting forwards; internal ridges and foveae obsolescent. Antennae rather long, second joint noticeably longer than first; club elongate, pedunculate. Prothorax, broad, flat or feebly concave, apex truncate above, ocular lobes absent; median line impressed; disc set with small, rather obscure granules, submedian tubercles not distinct from the granules, excepting the basal and sometimes the subbasal pair; lateral strongly projecting, trianguliform, the median the largest, slightly recurved, with a smaller one anteriorly, only conjoined at base, posterior slightly smaller than median, with a smaller tubercle more posteriorly. Elytra subparallel on sides for greater part of length; punctures indefinite, transversely confluent; all the interstices with rows of granules, larger on the alternate interstices, distinctly conical on the first, third and fifth posteriorly; humeral angles not advanced, with a row of small granules. Venter flat, moderately closely set with small, grey, decumbent, subsquamose setae, arising from rather large, foveiform punctures, less marked on apical segment. Legs simple.

♀. Similar, more ovate; elytra broader, more produced and briefly mucronate at apex, the posterior granules on first, third and fifth rows smaller and less conical; venter convex, punctures smaller. *Dimensions*: ♂. 14 × 5 mm.; ♀. 15.5 × 6 mm.

Hab.—South Australia: Port Lincoln.

The above description is drawn up from South Australian specimens in my own collection. The type of *crenaticollis* is a large female, measuring 18 × 7.5 mm.; it is stated to be from New South Wales, but I can find no difference between it and South Australian specimens and believe that the locality given is probably wrong. The species is more widely known under the synonym *A. irroratus* Macl., which was described from Port Lincoln. I am uncertain whether the types of this are in the Macleay or Australian Museum.

ACANTHOLOPHUS TERRAE-REGINAE n.sp.

Allied to *A. crenaticollis* Macl., but differing in the supraorbital crests.

♂. Black; with minute, sparse, muddy brown clothing.

Rostrum deeply concave above, the concavity practically continuous with that of forehead, separated by a transverse groove, the anterior edge of which, seen from behind, appears feebly raised; internal ridges obsolete and basal foveae obliterated; lateral margins strongly raised in an acutely angular process in the middle, sloping to base, but with a second angular projection anteriorly. Forehead deeply concave, with feeble obsolescent grooves radiating from base of rostrum; supraorbital crests erect, the apex divided into a short, obtuse, forward projecting ramus, and a longer more acute one, projecting upwards. Prothorax broad, almost flat, the median furrow well marked; median tubercles small, hardly distinct from the granules, which are present on the rest of the disc, excepting the sublateral areas; lateral tubercles outwardly projecting, rather blunt, hardly triangular, the anterior and median hardly conjoined, the postero-lateral large and followed by a smaller tubercle. Elytra with shallow indefinite punctures separated by low ridges, running on to interstices and giving derm a feebly wrinkled appearance; interstices granulate, the granules larger and more distinct on the third interstice, especially posteriorly where they are tuberculiform, and on the fifth interstice where they form a continuous row of small conical granules or tubercles, about 16 in number, running from humeral angle, which projects forwards and is lined by three of these granules, to edge of declivity; sides with interstices granulate. Ventral segments with scattered punctures bearing short decumbent setae, more numerous on apical segment. Legs simple; posterior tarsi rather short.

♀. Similar to male, broader, with more convex under surface. *Dimensions*: ♂. 15 × 5.5 mm.; ♀. 15 × 6 mm.

Hab.—Queensland: Chinchilla.

Type in Queensland Museum.

Six specimens (3 ♂, 3 ♀) under examination, from the same locality.

While closely allied to *A. crenaticollis* Macl., the present species differs in the double dentiform projection of the lateral rostral margins, in the differently shaped supraorbital crests, in the more evident prothoracic granules, and in the more evidently granulate elytral shoulders.

ACANTHOLOPHUS PLANICOLLIS Waterhouse.

Waterhouse, Trans. Ent. Soc. Lond., iii., 1854, p. 74; Lacordaire, Gen. Col., vi., 1863, p. 312, note; Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 290.

♂. Small; black, densely clothed with obscure, brownish, subsquamose pubescence.

Head concave in front, obsoletely longitudinally and obliquely rugose, with a pair of obscure granules about middle; separated from rostrum by an indistinct transverse groove, only traceable from behind; supraorbital crests broad at base, projecting laterally as much as forwards, bidentate, the anterior lobe convex forwards; hardly separated from posterior, except by a small indentation, sometimes absent, at apex of lobe, the posterior briefly pointed. Rostrum concave above; external margins raised, strongly convex, sometimes with a separate angulation anteriorly; internal ridges moderately distinct, convergent, continued almost to opposite the posterior margin of base of crests; foveae represented by an oblique groove from external margin to transverse sulcus at base of rostrum. Antennae with scape short and strongly incrassate; first and second joints of

funicle approximately equal; club stout, not pedunculate. Prothorax flat, anterior margin subtruncate above, ocular lobes absent; disc closely granulate, with a tendency to radial arrangement; median line hardly impressed; sub-median tubercles not distinct, with the exception of the basal and subbasal pairs; lateral margins strongly convex, with four or five dentiform tubercles, the median constriction rather feeble. Elytra with punctures obscure; all the interstices with rows of small granules, suture with a pair of small conical granules at edge of declivity; third and fifth with larger conical granules posteriorly, more or less separate on the third; seventh also with slightly larger granules; humeral angle with a row of small granules, extending backwards and obliquely outwards from angle. Venter flat; moderately densely clothed with long decumbent setae, mostly of a light yellowish-brown colour; punctures shallow, obscured by clothing. Legs simple.

♀. Larger and broader, otherwise much as in male; venter convex. *Dimensions*: ♂. 12.5 × 5 mm.; ♀. 15 × 6 mm.

Hab.—South Australia: Adelaide, Mt. Lofty, Victor Harbour; Victoria: Wandong Ra., Macedon, R. Plenty.

In general appearance this species closely resembles *A. denticollis*, but may be readily distinguished by the bidentate supraorbital crests, and by the simple anterior tibiae. I am indebted to Mr. J. E. Dixon for a series of Victorian specimens. The type was examined by me when in London.

ACANTHOLOPHUS DENTICOLLIS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 282.

♂. Size rather small; black, somewhat sparsely covered with minute, muddy-brown, subsquamose clothing.

Head not distinctly concave in front, with three obscure ridges converging on rostrum; head separated from rostrum by a distinct transverse groove; supraorbital crests single, continued back in line but at an obtuse angle with external rostral margins, and ending abruptly. Rostrum with external rostral margins raised, obtusely angulate in front and running back into supraorbital crests; median line impressed; internal ridges raised convergent to base but not meeting, basal foveae elongate. Antennae moderately long, funicle with second joint longer than first, club elongate, hardly pedunculate. Prothorax feebly convex in middle, anterior margin not produced over head, ocular lobes absent; median line rather shallowly impressed; disc closely set with round moderately large granules, submedian tubercles hardly distinct from the discal granules, except for one or two posteriorly; sides not greatly explanate, tubercles rather obtuse, the median the largest, with a smaller one conjoined anteriorly, the posterior slightly smaller than the median and followed by two smaller dentiform tubercles, an intermediate tubercle present between median and posterior, but on a lower level. Elytra with punctures fairly definite, and granules little evident; suture with a conjoined pair of granules on edge of declivity; with three rows of tubercles; first row with 8, the basal ones small and noduliform, the last 2—3 larger and somewhat obtusely conical; second row with 6—7, noduliform tubercles, the last 3 obtusely conical; humeral angle with two small nodules; third row with 5—6 small noduliform tubercles, hardly more than mere granules. Venter flat, moderately closely set with black decumbent rather short, stout setae. Legs: anterior tibiae with deep subapical notch; intermediate and posterior tibiae simple.

♀. As in ♂., but broader, and elytra more produced, with rather smaller and more numerous tubercles; venter lightly convex; anterior tibiae simple. *Dimensions*: ♂. 14 × 5.5 mm.; ♀. 15 × 6.5 mm.

Hab.—N.S. Wales; Victoria.

The above description is drawn from the types in the Macleay Museum and which were taken at Kurrajong.

I have before me specimens from various places in New South Wales and Victoria, which I certainly regard as conspecific with the types but which nevertheless show considerable variation from the types and also *inter se.* It is possible that some, at any rate, of these forms should be regarded as worthy of subspecific rank, but the series are hardly long enough to justify an opinion. In this category comes *A. serraticollis* Macl., but there is more reason to justify the separation of this form at any rate subspecifically.

These variations may be considered in some detail.

Specimens (3 ♂) from the Blue Mountains, probably from Blackheath, agree with the types.

♂. ♀. from Portland, N.S. Wales differ in the following details: Supraorbital crests larger; antennae with second funicular joint hardly longer than first; prothorax with anterior, median and intermediate lateral tubercles fused to form a tridentate ridge, the posterior tubercle smaller, and the sides rather suddenly narrowed behind it, so that the prothorax is somewhat cordate in shape; elytral tubercles 8, 7, 7 in number, the humeral angle with a single nodule.

♂. ♀. from Blackheath, Blue Mountains. Head with ridges more distinct, and rostrum with median line carinate; supraorbital crests smaller, and continued back in line with rostral margins, with hardly any angle at junction; antennae with first and second joints of funicle subequal; prothorax much as in the Portland specimens; elytral tubercles 9, 9, 5—6.

A series of 8 specimens (♂, ♀) from Mt. Kosciusko approach closely to the types; the supraorbital crests, however, show feeble evidence of bidentation; the antennae have the second joint slightly longer than the first; the prothorax is narrower, but with lateral tubercles as in the types; elytra with more evident granules, the first row of tubercles degenerated into a row of mere granules, the last 4 distinct as tubercles; second row with 8—11; shoulders with two small granules behind one another; third with 5—6, little more than granules. The females are similar to the males but the crests are more distinctly bidentate and the anterior angle of the external rostral ridge is more marked.

3 ♂ from Sydney agree with type, except that the general sculpture is somewhat coarser, and the posterior lateral tubercles of the prothorax are larger.

Specimens from Woodford (1 ♀) and Mittagong (1 ♀) agree with female type, except they are somewhat larger.

Specimens from Beechworth, Victoria (♂. ♀.) agree with types, except that there is slight evidence of bidentation of the supraorbital crests.

Var.

Specimens (1 ♂, 2 ♀) from Coonabarabran have a very distinctive appearance and at first sight appear to be specifically distinct, but I am unable to find characters to justify their separation except as a variety. ♂. Larger; black, with denser brown clothing, feebly variegate with grey.

Head more deeply concave in front, with grooves more marked, crests larger. Rostrum rather deeply excavate above, with the lateral margins more raised.

Prothorax wider and flatter, with very deep anterior constriction; tubercles as in type. Elytra with tubercles more numerous, smaller, and more closely set, 12, 10 and 6 in number, granules on other interstices more evident.

♀. Differs in similar manner from ♀ type. *Dimensions*: ♂. 16 × 6 mm.; ♀. 16-18 × 7-7.5 mm.

Hab.—N.S. Wales: Coonabarabran (T. G. Sloane and Macleay Museum).

Var.—SERRATICOLLIS Macl., Trans. Ent. Soc. N.S. Wales, i., 1865, p. 282.

♂. Supraorbital crests larger, feebly bidentate. Rostrum with lateral margins more acutely angulate anteriorly; median line impressed. (Antennae broken.) Prothorax broader, the disc with much smaller granules and with the submedian tubercles more distinct; lateral margins with anterior and median tubercles almost completely conjoined, the posterior triangular, acute, with a smaller tubercle conjoined at base and another at basal angle. Elytra with punctures more obscure; tubercles 8, 9, and 5 in number in the three rows; humeral angle with a small nodule. *Dimensions*: ♂. 15 × 5.5 mm.

Hab.—N.S. Wales: Wingello, Shoalhaven River.

The broader prothorax appears to me to be the best distinguishing character of this form. The bidentate crests and the more marked angulation of the external rostral margins occur in other forms of *A. denticollis*. My specimens are from the Shoalhaven River and were given to me by Mr. W. W. Froggatt; they probably come from the upper portion of the river. The only difference between them and the type is that the prothoracic granules are more distinct.

ACANTHOLOPHUS EXIMIUS Macl.

Cubicorrhynchus eximius Macleay, Trans. Ent. Soc. N.S. Wales, i., 1866, p. 332; Lea, Trans. Roy. Soc. S. Aust., xxxiv., 1910, p. 18.

♂. Large, elongate, subparallel. Densely clothed with brown subsquamose pubescence, maculate with grey on elytra; sides with white along middle of prothorax and maculate on elytra.

Head impressed in front, separated from rostrum by a transverse groove; with a feeble longitudinal ridge in median line, and two separate granules midway down forehead; supraorbital crests rather short and obtuse, bidentate. Rostrum widely excavate, lateral margins little raised, with a small spicule anteriorly, median line deeply impressed. Antennae long, moderately stout; funicle with basal two joints rather long, subequal; club moderately long, pedunculate. Prothorax subtruncate above, with no trace of ocular lobes; disc flattened, the median line hardly impressed, with rather distantly placed, moderately large, distinct granules, slightly larger on each side of median line, the penultimate tubercle distinct; lateral margins with a short sharp tubercle in front of middle, and another shorter one anterior to it, posterior lateral tubercle represented by a small granule. Elytra elongate, almost subparallel on sides; with fairly regular rows of small foveiform punctures, the interstices with distinct rounded granules; with three rows of tubercles, first row about 11 in number, the basal ones mere granules, slightly larger than the granules on the intermediate interstices, becoming larger posteriorly, then conical, the last 3 large and acutely conical, extending on to declivity; second row with 8—9 tubercles, larger than the tubercles of first row, the basal 6 small and obtuse, the rest conical, becoming progressively larger and more acute, not reaching so posterior a level as the first row; humeral angle with a small tubercle; third row with 5, the first moderately large and

acute, the remainder decreasing in size. Venter gently transversely convex; strongly nitid, with few obsolete setigerous punctures, more evident at sides, the extreme apex rather rugosely punctured. Legs simple.

♀. Wider; elytra more rounded on sides; venter more convex. *Dimensions*: ♂. 18 × 6 mm.

Hab.—Western Australia: Stirling Ranges.

The above description is taken from the specimen in the Macleay Museum which is a male; the Australian Museum specimens, presumably the types, are females; these were compared with the male some years ago and agree with it except for the usual sexual differences.

The species was originally described as a *Cubicorrhynchus*, but Lea removed it to *Acantholophus* and it certainly is congeneric with the other species placed in the second section of *Acantholophus*.

A. eximius is related most nearly to *A. scaphirostris* Ferg., but is a larger flatter insect with coarser granules.

ACANTHOLOPHUS SCAPHIROSTRIS Ferg.

Ferguson, Trans. Roy. Soc. S. Aust., xxxix., 1915, p. 73.

Though allied to *A. eximius* Macl., the present species may be distinguished by its smaller size and more convex form. The lateral prothoracic tubercles are more obtuse, and the elytral tubercles smaller, while the elytral punctures and granules are much less distinct, also the venter is not strongly nitid.

Hab.—Western Australia: Bridgetown.

ACANTHOLOPHUS GRANULATUS Sloane.

Sloane, Trans. Roy. Soc. S. Aust., xvi., 1892, p. 231.

The type of this species, now in the South Australian Museum, was examined some years ago. The male alone was known to Mr. Sloane; it came from Barrow Range, but the Museum also possessed a female from Everard Range.

The species is closely allied to *A. maximus* Macl., and certainly cannot be separated generically. The chief distinctions are in the form of the supraorbital crests and in the lateral tubercles of the prothorax. The crests are not bidentate above, the two rami being completely fused. The prothorax is flatter and the lateral tubercles are subconical and more distinct than in the normal form, though some specimens of *A. maximus* have the lateral tubercles more strongly developed. The elytral granules are duplicated on some of the interstices.

The female is broader than the male, but otherwise very similar; the crests are, however, very slightly dentate above.

ACANTHOLOPHUS BLACKBURNI Ferg.

Ferguson, Trans. Roy. Soc. S. Aust., xxxix., 1915, p. 59; *A. simplex*, Blackburn (*nom praeocc.*), Report Horn Exped., 1896, p. 292.

This species is closely allied to *A. granulatus* Sloane and *A. maximus* Macl. Compared with the male of *A. granulatus*, the present species differs in having the supraorbital crests distinctly bidentate, the posterior dentation being the longer. The prothorax has the granules less evenly distributed and the lateral tubercles blunter; these differences may not, however, be constant, and the elytral granules

being in single rows on all the interstices perhaps affords a better distinction.

The female type in the South Australian Museum has also been examined. It differs from the male commented on above, which was from Palm Creek (National Museum) in being smaller and more ovate. The crests had smaller but distinct dentations, and the lateral prothoracic tubercles were narrower and more sharply conical.

From *A. maximus*, it may be distinguished by the arrangement of the elytral granules, but both *A. blackburni* and *A. granulatus* differ from *A. maximus* in their more slender *Acantholophus*-like form.

Acantholophus maximus Macl.

Cubicorrhynchus maximus Macl., Trans. Ent. Soc. N.S. Wales, i., 1865, p. 294.

♂. Of moderate size, robust. Black, with very scanty grey clothing.

Head convex above, concave in front and with longitudinal and oblique ridges converging on apex and separated by deep grooves, with two small granules about middle; separated from rostrum by a deep transverse groove bifurcate at ends; supraorbital crests stout, obtusely bidentate, the posterior fork of the transverse apical groove running up the inner side of crest between the two portions, the anterior fork running between crest and the end of the lateral margin of the rostrum. Rostrum short and wide, the upper surface rather deeply concave, without internal ridges or basal foveae; lateral margins strongly raised, almost rectangulate in front and sinking suddenly at base. Antennae comparatively short; first joint of funicle noticeably longer than second; club rather stout, elongate. Prothorax subquadrate, gently rounded on sides; apical margin feebly rounded above, not produced over head, ocular lobes absent; disc gently convex, not explanate, uniformly and closely set with moderately large distinct granules; median line rather shallowly impressed, submedian tubercles absent except for small basal pair; lateral tubercles represented by two small dentiform projections anteriorly and one or two smaller more indefinite ones posteriorly. Sides granulate, the granules becoming obsolete below. Elytra broad, gently rounded on sides, base slightly emarginate, humeral angles marked by a small tooth; disc striate-punctate, the punctures open, often confluent laterally, giving elytra a somewhat wrinkled appearance; interstices closely set with moderately large granules, round at base, but conical posteriorly, for the most part in single series, but duplicated on basal portions of second, third and fourth interstices. Ventral segments transversely convex, the basal segments rather feebly concave; without evident punctures except for a few at extreme apex. Legs short and stout; femora somewhat flattened with transverse impressions; tibiae short and stout, with rather strong yellow setae, larger on the under surface; tarsal joints shorter and broader than usual.

♀. Very similar to ♂, somewhat more obese; venter more strongly convex; legs somewhat longer. *Dimensions*: ♂. 14 × 6—17 × 7 mm.; ♀. 17 × 7—20 × 8 mm.

Hab.—Western Australia: King George Sound, Swan River, Mundaring, Conjerdin, Gooseberry Hill, Kalgoorlie, Cue.

The type of this species, which is in the Macleay Museum, is a female, and agrees exactly with the female from Mundaring described above.

The series before me shows some considerable variation in size and in the lateral prothoracic tubercles. These tend to become distinctly larger, and in specimens from Cue there is an additional tubercle filling the gap between the

anterior and posterior pairs, but on a somewhat lower plane. These specimens at first sight might be regarded as belonging at least to a distinct variety, but they are connected by intermediate forms. There is also in some specimens a tendency for the second tubercle of the posterior pair to become obsolete. Comparison with *A. blackburni* shows that the two anterior tubercles and the first of the posterior pair correspond to the three tubercles present in most species; the middle tubercle in the Cue specimens corresponds to the small granule seen at the base of the median tubercle in other species.

The position of *A. maximus* Macleay is open to considerable discussion. Macleay described it as a species of *Cubicorrhynchus* and subsequent authors have allowed it to remain in that genus. Lea regarded it as congeneric with *Molochtus gagates* Pasc., and placed the latter species under *Cubicorrhynchus.*

In its general appearance and sculpture *maximus* undoubtedly resembles both *Cubicorrhynchus* and *Molochtus,* but I cannot regard it as congeneric with either. The reasons for maintaining *Molochtus* as a valid genus I have already given and the characters laid down exclude *maximus.* From *Cubicorrhynchus* it is separated by the deep concavity of the rostrum.

I regard it as unquestionably congeneric with *Acantholophus granulatus* Sloane and *A. blackburni* Ferg. (= *A. simplex* Blackb.) though neither Sloane nor Blackburn referred to this species in their observations.

If the two latter species are allowed to remain in *Acantholophus* then *maximus* must be placed there too.

THE HIGH TEMPERATURE ORGANISM OF FERMENTING TAN-BARK.

Part i.

By R. Greig-Smith, D.Sc., Macleay Bacteriologist to the Society.

(Four Text-figures.)

In the manufacture of white lead, plates of metallic lead are generally corroded by the old Dutch fermentation process. As conducted at the works of Lewis Berger and Co. at Rhodes, near Sydney, the fermentation stacks are built up of layers of tan-bark with the lead contained in pots between successive layers of bark. A layer of bark some twenty-four inches deep is first laid on the floor, and on this are placed the earthenware pots each containing about three inches of dilute acetic acid and about eighteen perforated sheets of lead (buckles) all resting upon a ledge in the jar. The jars are covered with timber and on the timber a layer of sixteen inches of tempered tan-bark is placed; then comes a layer of jars, then timber, and so the stack is built up. Each tier of jars is connected with the air at the top of the stack by means of wooden chimneys, the vent of each chimney being covered with a piece of wood. When the fermentation is at its height, steam rushes out of the vents and the extraordinary thing is that the temperature of the issuing steam is in the neighbourhood of 180° F. This is a remarkably high temperature for there is some evidence in favour of the fermentation being due to the activity of micro-organisms.

The fermentation occupies about four months and, in its course, the lead is carbonated with an efficiency of from 60 to 80 %, while the temperature, starting at about 140° F., rises during the second month to from 180° to 190° and then falls to about 140° when the stacks are drawn. The bark darkens in colour, shrinks in volume and becomes less fibrous. It is used again, but in order to adjust the wastage and to improve the texture, it is mixed with one part of new bark for every four parts of old tempered bark when the stacks are made.

The tanners of Sydney use wattle-bark in preparing their tan liquors and Lewis Berger and Co. have found that the fermentation of this kind of bark requires a different treatment from the barks used in other parts of the world. A preliminary fermentation or tempering is necessary. This consists in storing the bark in a central reserve or alley and watering it daily for about a fortnight. The temperature of the mass rises to well over blood heat, but not to the temperature that it attains in the stacks. One can see lumps of bark on the top of

the heap covered with a white mould, and a portion taken from well inside the heap contained budding yeast-like cells. These were living, for they did not become stained by watery eosin. It is possible that this preliminary mixed fermentation at a comparatively low temperature brings about the production of certain nutrients which are necessary for the life of high temperature bacteria in the main fermentation. However this is a matter for future investigation.

A sample of bark was taken from a stack when the top tier was in active fermentation. Digging down about six inches, the temperature was found to be 180° F. and a sterile bottle was filled with the hot bark, taken to the laboratory and subjected to investigation.

It may be mentioned here that a sample of the tempered bark contained 50.5 % of water driven off at 100° and 51.7 % at 130° C. while the stack-bark lost 59.7 % at 100°, and 61.9 % at 130°.

The microscopic examination of a watery suspension of the bark showed stout rods of various lengths, and threads. It was thought that the latter might be actinomyces-forms but as an *Actinomyces* colony was only once found upon the plates, it is probable that they were bacterial threads. During the investigation, it was noted that the bacteria formed threads of various lengths very easily. They occurred in the older cultures and may be looked upon as degenerate or involution forms.

A high temperature organism was eventually obtained but before this occurred some observations were made which led up to the successful issue. As plate cultivation at 60° is not an easy method of isolating bacteria, an attempt was made at 37°. Unfortunately the colonies that developed would not grow at 60°. Had the incubation of the plates been prolonged, punctiform colonies would have appeared; one race of the thermophilic organisms was subsequently obtained in this way. A preliminary incubation of the bark with water was found to be necessary and it was shown, later, that an alkaline liquid was very much better. Colonies were obtained by stroking agar-slopes with suspensions of the incubated bark and also by smearing plates which in order to minimise the drying and condensation that occurs at 60° were wrapped in butter-paper and put into damp chambers or larger Petri-dishes. With regard to the tubes, the plugs were pushed down and the mouths loosely closed with ordinary wooden corks. Rubber caps perish quickly at 60°.

The first trials with ordinary nutrient agar were negative; no growths were obtained and this led to the preparation of a special saccharose agar medium. Later work, however, showed that the ordinary nutrient agar was quite good for growing the high temperature organism, and the negative preliminary tests must have been due to the ignorance of the necessity for a preliminary incubation of the bark with water or with dilute alkali.

The agar-medium suggested by the early test consisted of saccharose 1 %, peptone 0.3 %, meat-extract 0.2 %, potassium citrate 0.3 %, magnesium sulphate crystals 0.2 %, and calcium chloride 0.05 %, made neutral to phenolphthalein. It proved a very suitable medium but, as it had a tendency to soften and the slopes slid down in their tubes when incubated at 60°, the second batch was made with 2.5 % of agar. The first active growths were obtained on this medium from a portion of the stack-bark that had been covered with water and incubated at 60°. The suspension was smeared over an agar slope and in 20 hours at 60° a luxuriant growth had spread over the agar which was broken up with numerous

gas bubbles.* The mixed culture had decomposed the saccharose with evolution of gas. From this culture other slopes were smeared and a number of colonies were obtained. Although these grew well at 60°, they failed to produce gas. A more vigorous gas formation was obtained from the mixed culture derived from another flask of bark which had been covered with N/100 sodium hydrate and which itself showed signs of gas formation, although it was doubtful whether the bubbles entrapped in the bark were derived from the fermentation of the bark or from the air absorbed or caught in the spaces of the bark. The examination of the gassy agar-tubes, by tube and by plate culture at 60°, showed only one kind of colony and the organism was not a saccharose fermenter.

Although the fermentation of saccharose was not the object of the research, it seemed probable that a definite saccharose-fermenting bacterium would be more likely to be able to ferment cellulose than one which could not do so. Consequently a rather extended search was made for this active organism, and gradually it was determined that the gas fermentation of saccharose (and of dextrose) was the result of a condition and not due to an admixture with an unknown organism. During the search, notes were made upon the nature and activities of the thermophilic bacterium.

It is a stout rod of a general length of from 3 to 4.5μ but varying from 1.5 up to 15μ or longer. Its breadth is 0.7μ. Spores are formed terminally; they are oval at first, but become rounded. Their general size is $0.9 \times 1.5\mu$. The rods when grown in saccharose media at 60° were Gram negative; at 37° they were Gram positive. Although non-motile in fluid media, the rods were studded with many peritrichous flagella.

The colonies on saccharose agar were white and rounded and often became irregular with age. They were either translucent white or semi-opaque and rough or terraced (button-like). Microscopically, they had generally a granular centre which gradually thinned off to a clear margin. Sometimes the structure appeared rippled or wavy and sometimes faintly radial. The edge was sometimes smooth, sometimes lacerate. Much seemed to depend upon the amount of spore formation that had taken place, and the consistency of the agar. An almost translucent colony with a wavy structure when transferred to sloped agar gave an opaque rough stroke and, conversely, an opaque colony gave a smooth translucent expansion.

Some races of the bacteria grew slowly at 37° while others did not. They all grew well at 60° and not quite so strongly at 65° or at 70°. At the latter temperature some races failed to grow, and this raised the suspicion that much had yet to be learned about the acclimatisation of the bacteria and their spores. Throughout the research there was always a doubt as to whether a particular culture would transfer. An actively growing culture would always transfer but the same could not be said of a culture which had been at laboratory temperature for days or weeks or at 60° for a few days.

When grown upon saccharose-agar coloured with litmus, the bacteria seemed to have a double action (see p. 83). With gradually increasing acidity, the

* This production of gas was an exceptional case, for later tests showed that a preliminary treatment in an alkaline liquid or the presence of alkali in the agar itself was necessary. But it must be borne in mind that when bacteria have been recently isolated from what may be called their natural habitat, they may be and probably are more vigorous than after a spell of subcultivation in the laboratory.

growths became depressed progressively, making it clear that an acid condition of the medium is unsuitable. In dextrose and saccharose litmus broths, the media became reddened and then bleached but the growth was feeble. Meat extract is not a suitable source of nitrogen. Urea and ammonium salts are quite unsuitable while on the other hand peptone and asparagin are good.

In peptone water with nitrate, the nitrate is reduced to nitrite.

In the primary isolation of the high temperature organism, growths were obtained from stack-bark which had been wetted with water and with N/100 sodium hydrate and, of the two, the soda contained the greater number of bacteria per loop of suspension. In following up this observation, stack-bark was put into bottles and wetted with dilute sodium hydrate of varying strengths. The liquids rose half way to the surface of the bark. The bottles were closed with corks fitted with glass tubes drawn out at one end to a capillary point in order to lessen the evaporation of the liquid contents. They were incubated at 70° and from these growths were obtained, but as no gas was produced in saccharose agar, it was considered that 70° was too high for laboratory work. Accordingly new portions of stack-bark were taken, wetted with sodium carbonate and incubated at 60°. The growth and gas-formation produced by stroking loops of the alkaline liquors on saccharose agar are noted in the table.

Bark with Na_2CO_3.	N/2·5		N/5		N/10		N/25	N/50
	growth	gas	growth	gas	growth	gas	growth	growth
1 day	+	O	+	O	+	O	O	O
4 days	+++	+	+++	+	+++	+	+	+
6 days	+++	O	+++	+	+++	+	+	+
10 days	+++	O	+++	+	+++	+	O	O
13 days	++	S	+++	S	+++	+	O	O
18 days	++	S	+++	S	+++	S	O	O

S=slight.

Another experiment with stronger dilutions of sodium carbonate was made and the following results were obtained.

Bark with Na_2CO_3.	N/0·5		N/1·25		N/2·5	
	growth	gas	growth	gas	growth	gas
1 day	+	O	++	O	++	+
5 days	O	O	+++	O	+++	+
8 days	O	O	++	O	+++	S

S = slight.

A bulk culture in N/5 sodium carbonate gave a gas-forming growth in two days, but not in one day.

The experiments show that N/5 or N/10 sodium carbonate is best for developing the organism that produces gas in saccharose-agar. The organism is contained in the condensed water of the slopes which show gas formation and when this water was seeded into litmus broth containing either saccharose or

dextrose there was a production of acid and of gas in 5 days at 60°.* The colonies that developed on the agar slopes contained the rod-shaped bacteria already noted, and as these did not produce gas, either in agar or in broth, it is evident that the gas-producer is difficult to obtain. Some seventy colonies had been picked out and none of them were gas producers. In films prepared from the condensed water, one could see the stout bacteria accompanied by long, thin, faintly staining rods. In old nutrient agar cultures, and especially in Hansen's fluid, thin rods with central granules or with terminal granules were noted and it therefore seems unlikely that the faintly staining rods are the gas-producing bacteria. By the negative method of staining one could see here and there structures which might be either spirochaetes or flagella but they were neither sufficiently numerous nor sufficiently decided to be the active agent. Although the large rod-shaped bacteria were non-motile yet when appropriately stained they were seen to have many peritrichous flagella and it is possible that a few were shown by the negative stain.

In dextrose broth containing various nitrogenous nutrients such as meat-extract, asparagin, urea or ammonium phosphate, acid and bleaching were produced in the first two and no gas was formed in any. The infecting material was the condensed water of a gassy culture, so that it is probable that the active organism does not grow freely in fluids.

A repetition of the experiment with the same kind of infecting material gave in the case of asparagin a production of gas by the 5th day. It was noted that by this time the growth was very considerable, the broth being quite opaque. It was also noted that on the day following, the gas-bubbles were absent and the volume of gas in the inner tube was less. The evolution of gas had apparently stopped on the fifth day and whether this was due to a lack of nutrition or to the sudden cooling of the culture on the fifth day during examination, further experiment must decide. The active liquid was, on the fifth day, seeded into new asparagin broth and one day later this was bleached, showing a turbidity at the surface. No gas developed even after twenty days.

It must not be considered that treatment of the bark is necessary to obtain a growth of thermophilic organisms. These can be obtained directly from the bark by rubbing fragments over an agar slope. These however do not produce gas in the medium.

Having apparently failed to obtain a pure culture of the active organism, it was decided to try the effect of an infusion of tan-bark. Accordingly a quantity of bark was mixed with twice its weight of water and heated at 60° for half an hour, strained and filtered. The infusion was quite gummy and had an acidity to phenolphthalein of $+ 0.85°$. One c.c. of the infusion was added to saccharose-nutrient agar together with sodium carbonate to make the alkalinity $= -24°$. Upon the slopes colonies appeared and, at the same time, the medium was pierced with gas bubbles. Small colonies showed up on the second day and these were fished out and transferred to fresh slopes. The growths were all similar and apparently the same as had been obtained previously. No gas was formed on saccharose nutrient agar, but gas was produced in the same agar with the ad-

* An exceptional case. No gas was obtained in these media with the pure and necessarily older races. But it was the occurrence of this gas-production in the supposedly impure culture that prolonged the research until it became apparent that no other kind of organism could be obtained.

dition of the tan-bark infusion and sodium carbonate. The gas was probably not caused by the interaction of the tannin bodies with the sodium carbonate, for certain of the tubes which failed to show growth contained no gas bubbles. And as growth was necessary, it is possible that the faint acidity produced during growth may have given rise to the evolution of gas from the added carbonate. The gas bubbles disappeared when the tubes cooled down to laboratory temperature. It may be that the gum derived from the infusion assisted in holding the gas in the medium. Be this as it may, the colonies isolated from growths that gave gas formation, failed to produce gas in the absence of bark, and we may conclude that the gas in the bark-infusion tubes was due to the interaction of the infusion plus sodium carbonate and the acid formed by the bacteria from the sugar. An organism capable of fermenting saccharose directly was the object of the investigation at the moment.

A weaker infusion of tan-bark was made by adding three parts of water and letting the mixture stand at 22° for two hours. It was brighter and neutral and clearly contained very little tannin. Slopes of saccharose nutrient agar containing 11, 20, 27 and 33 % of this infusion were stroked with a pure culture but the growths obtained did not differ in any way from those without the infusion.

The strengthening of the saccharose nutrient agar by the addition of peptone, asparagin or meat-extract did not lead to the production of gas by the undoubtedly pure colonies. Thus up to this point the isolation of a saccharose fermenter in pure culture had not been accomplished.

About this time it was noted that the stack-bark, originally covered with dilute sodium carbonate* had a slight covering of a white mould. This consisted of a mass of aerial hyphae or conidiophores sprouting from the surface of the bark and carrying sessile or nearly sessile conidia along the length of the thread. They were quite short, about 0.14 mm. in length and the conidia seemed to be double and 10μ long when measured in air with a Leitz No. 8 objective. When immersed in water, the conidiophore measured 1.4μ in diameter and the conidia were oval or spindle-shaped, the latter shape being caused by a collar at one end, probably the remains of a short pedicel. In size they ranged from $2.8\text{-}3.5 \times 4\text{-}6\mu$. The length proved that when noted growing in the air, the conidia were in couples. The contents were granular and one rather long conidium in a stained film showed a light central portion suggestive of the possibility of the cell being able to divide in two. The mycelia in stained films showed as unstained threads with irregularly placed, deeply stained granules and very similar to the threads noted in the films prepared from the condensed water of active mixed bacterial cultures.

Attempts were made to pick off the minute conidia from the bark and sow them upon solid media for incubation at 60° but the results were disappointing; either a strong growth of the inactive thermophilic rod was obtained or the tubes remained sterile. Hanging drop cultivation was also without result. Increasing the acidity and the alkalinity of the media, using the condensed water of an active growth as the infecting material, were useless for augmenting the

* The stack-bark had been covered with N/5 sodium carbonate and kept at 60° for two days when the fluid was found to contain active gas formers. On the fourth day the liquid was used in testing for filter passers and the residual bark was half covered with N/10 soda. Four days later the liquid contained gas formers, and in another four days the mould was noted covering many fragments of bark.

growth of the active gas producer. The familiar spore-bearing rods persisted in coming up and no other organism could be isolated.

A bottle of active stack-bark originally covered with N/5 soda had been set aside in the incubator at 37° and had grown a good crop of *Aspergillus.* The same mould appeared in the original sample of stack-bark and had apparently survived the action of the soda and the lengthy exposure at 60°. With the idea that possibly this might be the active agent, a tube of saccharose nutrient agar was infected with the spores and incubated at 37°. In three days, gas bubbles appeared in the medium under a dense mycelial growth. It was also sown in combination with the thermophilic rod and incubated at 60° but there was no growth of mould apparent and no gas formed. An attempt to acclimatise the *Aspergillus* to 60° by gradually raising the temperature from 37° was a failure and the conclusion was come to that the *Aspergillus* was not responsible for the fermentation of the saccharose.

It had been noted that the fluid taken directly from an alkaline bark liquor and sown on saccharose nutrient agar, gave a good growth of bacteria and a medium blown up with gas bubbles. The turbid condensed water at the base of the slope, when transferred to a second agar-slope, sometimes gave rise to gas production but generally did not. Colonies picked from the first tube never produced gas. Thus the gas production was fugitive.

The failure to obtain a gas-forming organism in pure culture and indeed to obtain any organism capable of growing at 60° other than the drumstick rod led to the idea that probably an alkaline condition of the agar was necessary for the evolution of gas, just as it was necessary to stimulate the growth of the cells from the bark. Possibly enough alkali was contained in the large loop used for seeding the tubes from the alkaline bark liquids, and as this disappeared on subculture so did the gas formation.

The saccharose nutrient agar had an acidity to phenolphthalein of + 2.2° and tubes of this were treated with increasing quantities of normal sodium carbonate and seeded with the condensed water of an active culture. Growth and gas were obtained on media having an alkalinity of — 14.4° and over, but not in media ranging from + 2.2° to — 12°. The limiting amount for growth appeared to be about — 24°, for with this alkalinity and with — 26.3° the agar had to be seeded several times.

Some of the races which had been isolated at different times, and were presumably pure, were grown on agar brought to approximately — 13° with Na_2CO_3. Out of 16 races, two failed to grow, three gave a growth of cells and no gas while the remainder produced growth with gas. The inactive bacteria could not be distinguished from the others.

The gas seems to be produced from the sugar, for tubes of alkalised nutrient agar without sugar gave luxuriant growths without gas when seeded with a culture which gave gas in the presence of sugar.

Thus we arrive at the fact that the drum-stick rod is the gas producer, and that the production of gas from saccharose by the pure races of the bacterium depends upon an alkaline condition of the medium.

An experiment was made with saccharose nutrient agar coloured with litmus and treated with increasing quantities of sodium carbonate. The slopes were stroked with an active race.

Alkalinity.	Notes.
+2° -1·7° -5·4° -9·1°	(one day): all pale red below condensed water level, condensed water strongly red, top of slope quite blue, gas bubbles in agar of -9·1°. (two days): showed progressive bleaching from +2° to -9·1°, upper parts of slopes quite blue, lower parts reddish, gas bubbles have disappeared from agar of -9·1°. (three days): +2° and -1·7° purple at top of slope, -5·4° and -9·1° blue at top of slope and body of agar bleached.
-12·8° -16·5°	(one day): no growth, reseeded with -9·1° culture. (two days): good growth, colour bleached below condensed water level and agar cracked with gas bubbles ; lower 2 cm. of slope red and upper 3 cm. quite blue. (three days): gas bubbles in both, -12·8° blue and -16·5° purple at top of slope.

From these notes it is evident that the bacteria produce acid from saccharose, that the gas production begins when the alkalinity is about — 9.1° and is pronounced at about — 12.8° and that the acid is possibly volatile at 60°, as was shown by the rather persistent blue colour of the thin layers of medium.

It had been found that the ordinary fluid media of the laboratory were not well suited for the growth of the bacterium and that urea, meat extract, and ammonia were useless as sources of nitrogen. Peptone water gave a fair growth, while asparagin was a good nutrient. To see how far an alkaline condition would improve matters, an experiment was made with meat extract, ammonium phosphate, urea and asparagin all 1 %, with 1 % dextrose, salts and litmus solution. Each tube received an increasing amount of sodium carbonate.

Absolutely no growth occurred with urea and ammonia. Meat extract developed an acidity with the control and — 4°, and no growth appeared in the others.

In from two to six days the asparagin became acid and bleached with 0, — 4°, — 8° and — 16°, but no growth occurred in — 20°. In 16 days gas had shown in the tubes with from — 4° to — 12°, and, by the 20th day, gas had developed in the control. Fresh tubes of asparagin were seeded from the — 8° culture and these showed acid and bleaching in three days with the same strengths of alkali as before. On the eighth day all the tubes up to — 16° were bleached and contained gas. The fluids were all alkaline to litmus paper. There was no growth in — 20°.

Litmus milk in five days was digested, bleached and was alkaline to litmus paper. Unsterilised milk in four days was partly digested and was alkaline to litmus paper. Several controls were unaffected.

Meanwhile experiments were in progress to see if the thermophilic rod could ferment tan-bark. The bark after sterilisation at 150° for an hour, was wetted, seeded with the organism and heated at 60° in a current of air. Several experiments which could only be considered as preliminary showed that certain precautions were necessary. Heating the bark in flasks in an incubator at 60° was unsuitable, for the hot dry air caused the rubber corks to harden and the rubber connections to loosen, with the result that the air and carbon dioxide were

sucked into the apparatus. Two flasks in series, each containing 50 c.c. of N/10 baryta water, coloured with phenolphthalein, were found to suffice for trapping all the CO_2. The decolorisation of the first flask was the signal for titrating the liquids in both flasks. The flasks themselves were fitted with wide tubes to avoid any tendency to blocking by the barium carbonate, which is largely deposited around the end of the inlet tube. It was unnecessary to have a flask of water in the thermostat connected with the other containing the bark in order to prevent the latter becoming too dry.

In the experiment about to be described the air passed through a tube of soda-lime, then through a Woulff bottle containing N/3 baryta water, thence through the flask with the bark, through two Wanklyn flasks in series containing baryta water and sometimes through an air-regulating flask to an air-reservoir connected with a suction pump.

The stack-bark that was used was acid, and a rough test indicated that the acidity was about 2.25 c.c. of N/1 acid per 100 grams of dry bark. The acidity is of some importance, because we have seen that the thermophilic bacteria develop from the bark only when it is made alkaline. The gas in saccharose media also formed in the presence of a certain amount of alkali. One might think, therefore, that in the stack, the bark would make the attached water acid, and thus prevent the growth of the bacteria and the fermentation of the bark. But conditions that affect bacteria in the laboratory do not have the same influence on the large or manufacturing scale. The acetic bacteria, for example, work at a temperature of 45° in a 5,000 gallon vat and they would not grow at this temperature in the laboratory in small bottles. The thermophilic rod from the stack-bark grows at 80° in the corroding stacks, but it grows best at 60° in the laboratory. It must also be remembered that in the laboratory we desire to see results in a few days while on the large scale, as in lead corrosion, the fermentation goes on for several months. The slow fermentation will probably ensure a better corrosion and in any case a rapid evolution of gas, if it could occur, might be of the nature of an explosion. So much for the condition of temperature. With regard to the acidity, one can imagine that bacteria will slowly produce change in large masses of fermentable organic matter such as silage, or acetic wort having an acidity that would render them inactive on a laboratory scale.

Some of the tempered bark was dried at 130° and divided into two portions of 30 grams each. These were heated in the oven at 150° for two hours. Each was treated with 20 c.c. of N/10 sodium hydrate and 50 c.c. of water, but in the case of the test flask the water contained a suspension of bacteria (race 73). The flasks were connected up with the apparatus previously described.

Evolution of Carbon Dioxide from Tempered Bark.

Days	Control. Milligrams of CO_2.		Test. Milligrams of CO_2.	
		Total		Total
1	56	56	107	107
2	73	129	36	143
4	54	118	41	184
5	19	202	31	215
6	31	233	43	258

Films prepared at the end of two days showed deeply staining rods in each flask, and tubes seeded with the liquors on the fourth day, gave bacterial growths both in test and control. It is clear that an exposure to 150° for two hours was not sufficient to sterilise the bark and thus the production of the same amount of carbon dioxide in four days is explained. It was thought that the speed of the current of air passing through the flasks would have an influence upon the results, but later observations showed that the quantity passing through was sufficient to sweep out all the CO_2 produced. The quantity passing through per hour varied from 1.3 to 2.1 litres, with an average of 1.75.

Pending the arrival of a quantity of stack and tempered barks, use was made of tan-bark in an experiment similar to the preceding. The preliminary experiments did not promise that a satisfactory result would be obtained from the untempered tan-bark, and it may be that the tannin remaining in the bark restricts the activity of the bacteria. The bark was dried at 130° and two portions of 24 grams were weighed into flasks and sterilised at 150° to 190° for three hours. This treatment was very drastic, but the previous experiment had shown that two hours at 150° was not enough to destroy all the spores. The control bark was wetted with 40 c.c. of N/20 sodium hydrate and the test with the same number of c.c. containing a suspension of the rods and spores of race 552 which actively decomposed saccharose in alkaline agar.

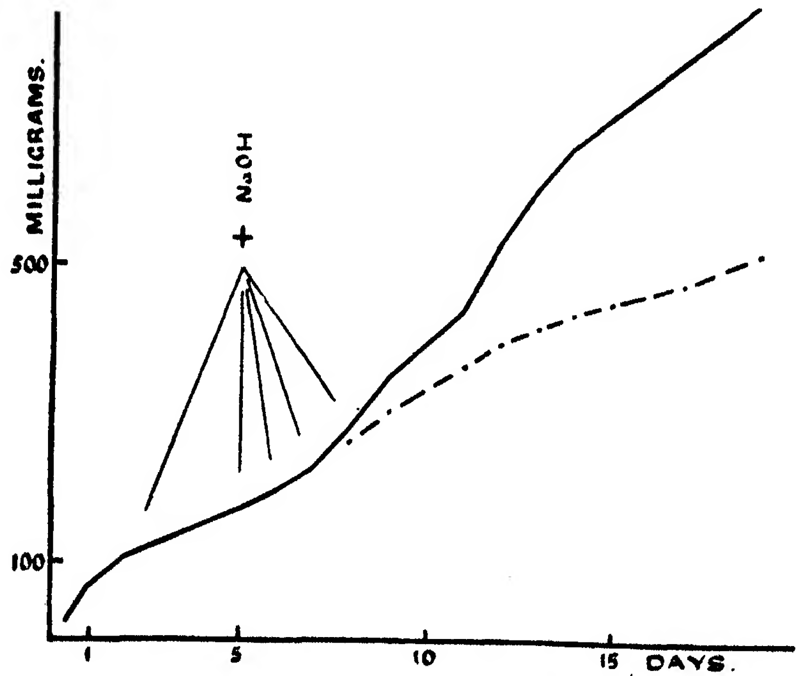
Evolution of Carbon Dioxide from Tan-bark.

Days.	Control. Milligrams of CO_2.		Test. Milligrams of CO_2.	
		Total.		Total.
	+ 40 c.c. N/20 NaOH			
1	73	73	72	72
2	40	113	37	109
	+ 10 c.c. N/10 NaOH			
5	61	174	69	178
	+ 20 c.c. N/10 NaOH			
6	24	198	24	202
	+ 5 c.c. N/1.85 NaOH			
7	25	223	29	231
	+ 10 c.c. N/1.85 NaOH			
8	44	267	55	286
	+ 10 c.c. N/1.85 NaOH			
9	41	308	63	349
11	60	386	93	442
12	26	394	86	528
13	20	414	70	598
14	19	433	56	654
15	15	448	41	695
17	29	477	74	769
19	37	514	84	853

Films were prepared at the end of the first day, and these showed faintly staining rods and spores in the test fluid and nothing in the control. At the end of the second day the control fluid was sterile and the test contained living bacteria. As the liquid was found to be acid to litmus, 10 c.c. of sodium hydrate were added to each flask. Upon the succeeding days, the acid reaction

of the fluids led to further additions of alkali, as noted in the table. It was observed that the bark became darker in colour as time went on.

At the end of the fifth day, the difference in the results was very small and the conclusion was come to that the raw bark was useless for showing the activity of the bacteria. In order to utilise the apparatus pending the arrival of a quantity of tempered bark, the experiment was continued and it is fortunate that it was, for the later results showed that under the conditions there was a small but decided evolution of CO_2 from the bark impregnated with the bacteria. The repeated additions of alkali gave more liquid than was desired, but this could not be avoided. Were the experiment to be repeated, the weak alkali would naturally not be used. At the end of the eighth day, the test contained living bacteria and the control was sterile.



Text-fig. 1. The Fermentation of Tan-bark. Total yield of Carbon Dioxide. Unbroken line = test, broken line = control.

From the experimental results and from the curves, one can see that the bacteria were quiescent for six days and, from that time onwards, they began to attack some constituent of the bark and from it to produce carbon dioxide.

Thus we have a production of carbon dioxide due to what we may call a chemical oxidation, as evidenced by the control test, and also to a bacterial fermentation, as shown by the excess of the test over the control. On the tenth day, the fluids in the flasks had a slight acidity towards litmus paper. Although it is possible that the repeated addition of the alkali favoured the growth of the bacteria, yet an examination of the curves gives one the idea that it was re-

sponsible for the concave depression of these curves and that it may not have had any decided influence in the production of the carbon dioxide.

It seems that this bacterium is one that has to get accustomed to its environment, for it was slow to produce carbon dioxide from the tan bark, and it is slow to grow on alkaline media as shown in experiments with increasing alkali where the slopes with a comparatively high alkaline content had to be repeatedly seeded from growths on agar with a little less alkali. It may be that in the tan-bark there is a constituent, e.g., tannin, which prevents the ready growth of the bacteria.

The addition of sodium hydrate to the flasks containing the bark was suggested by the increased activity of the bacteria in alkaline solution. But there was another reason for its use. On a former occasion (These Proceedings, 1918, p. 162), I showed that the heating of leaf-mould for two hours at 130° resulted in the formation of acid, the barium salt of which was largely soluble in water. The amount produced was equivalent to about 31 c.c. of normal acid per 100 grams of dry organic matter. It is probable that a higher temperature will produce a larger amount of acid and that a bark after sterilisation in the laboratory will be more acid than it was before sterilisation. Thus the addition of alkali to neutralise this developed acidity was indicated.

An attempt to arrive at the amount of acid developed during sterilisation was made upon a sample of air-dried tempered bark. Ten gram portions were weighed out, one was treated with 100 c.c. of water, another was sterilised at 200° to 176° for two hours, and then treated with 100 c.c. of water. After three days, the liquids were filtered and diluted one half. Using Sorensen's fifteenth-normal solutions of primary and secondary phosphates and brom-cresol-purple as the indicator, the extract of the air-dried bark had a P_H. number of 6.8 and the sterilised bark of 6.47. Thus an increase in the acidity of the bark following the sterilisation is shown. As the extract of the sterilised bark was brought up to P_H. 6.8 by the addition of 0.1 c.c. of N/100 alkali per 5 c.c., it appears that 100 grams of air-dried bark during sterilisation developed an amount of ionic acidity equal to 4 c.c. of tenth normal acid. This is very much less than had been expected from the experiment with leaf-mould, and seems to show that far too much alkali had been added to the tan bark in the fermentation experiment. Still the alkali had been added on account of the liquor reddening litmus paper.

A fermentation test was made with tempered bark, but it proved a failure. The bark was air-dried, then dried at 130°, and of this dry bark, 40 gram portions were put into flasks and sterilised at 150° for half an hour, and at 170° for an hour and a half. The flasks received 70 c.c. of water, one containing a suspension of the bacillus. By the second day, the seeded flask had given off 206 milligrams of CO_2 and the control 121 milligrams. The fluids in both flasks were at this stage shown to contain living bacteria and it followed that the tempered bark had contained some very resistant spores. Cultures from the control flask showed the rod with terminal spores growing at first as translucent colonies and rather gummy. By the time that the impurity of the control had been demonstrated, the amount of CO_2 given off was 371 milligrams in the seeded flask and 329 in the control. Five grams of powdered copper sulphate were added to the control flask and the fermentation was continued. By the seventh day the seeded flask had given off 597 and the control 553 milligrams of CO_2, and the control still contained living bacteria. The copper sulphate had been added as a disinfectant, but it would seem that the constituents of the bark had

reacted with the salt, annulling its disinfecting action. The constant increase of the seeded over the control flask was probably due to the initial activity of the introduced organisms.

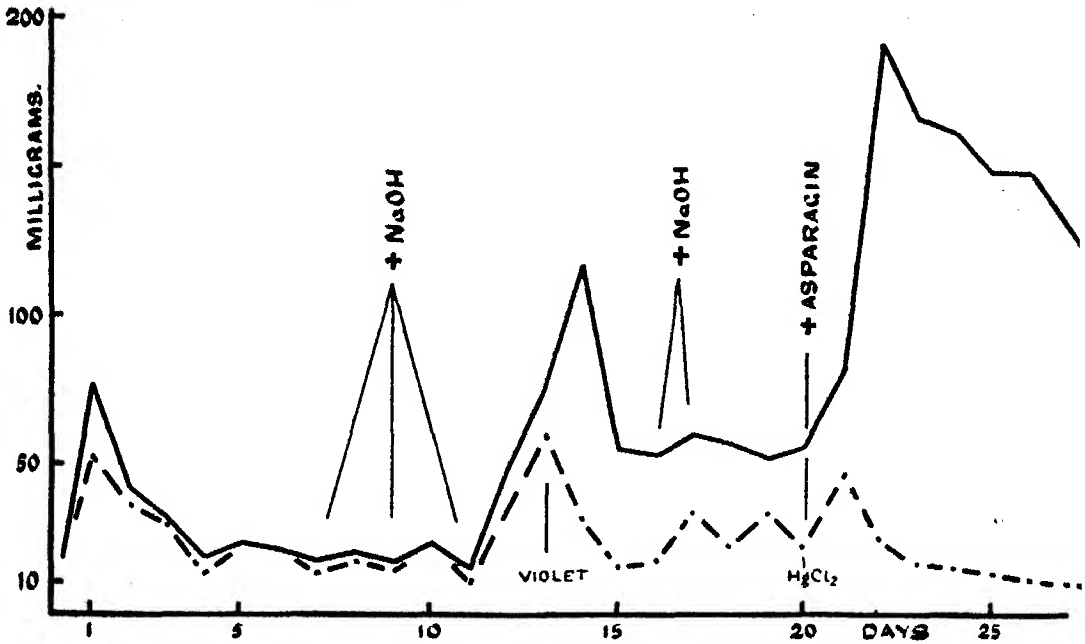
A fermentation experiment was made with tan-bark. Thirty grams of the bark dried at 130° were heated until a thermometer inserted in the control flask rose to 200°, then the temperature was slowly reduced to 164° during three-quarters of an hour and it was kept at this temperature for an hour and a quarter. Altogether the bark was sterilised for two hours at from 164° to 200°. The test flask was treated with 50 c.c. of water containing a suspension of race 80 which had been obtained from the control heated bark of the previous experiment.

Evolution of Carbon Dioxide from Tan-bark.

Days.	Control. Milligrams of CO_2. Daily	Total	Test. Milligrams of CO_2. Daily	Total.
1	53	53	77	77
2	36	89	42	119
3	29	118	32	151
4	13	131	18	169
5	22	153	23	192
6	21	174	21	213
7	13	187	17	230.
10 c.c. N/10 NaOH added.				
8	17	204	20	250
9	14	218	17	267
10 c.c. N/1.85 NaOH added.				
10	22	240	23	290
11	10	250	14	304
10 c.c. N/1 NaOH added.				
12	35	285	47	351
13	60	345	75	426
14	31	376	117	543
15	15	391	55	598
16	17	408	53	651
17	34	442	60	711
10 c.c. N/1 NaOH added.				
18	22	464	57	768
19	34	498	52	820
20	22	520	56	876
0.25 grams asparagin added.				
21	47	567	83	959
22	24	591	192	1151
23	16	607	167	1318
24	15	622	162	1480
25	13	635	149	1629
26	11	646	149	1778
27	10	656	131	1909
28	9	665	113	2022

On the seventh day the nature of the curve of the daily yields showed that a condition of equilibrium had been reached and something was needed to accelerate the evolution of gas. A previous experiment with the same bark had shown that alkali acted as such, and accordingly 10 c.c. of alkali were added to test

and control. The quantity advisable to add was as yet unknown and tenth normal sodium hydrate was used tentatively. This did not seem to improve matters and after the ninth day 10 c.c.* of N/1.85 sodium hydrate were added as a stronger alkali was apparently needed. The quantity of alkali added to each flask was capable of fixing 119 milligrams of CO_2, and as the yield was not completely depressed it is clear that the alkali was taken up by the bark and that it can absorb or fix much more alkali than the study of the aqueous extract would lead us to expect (see p. 87).



Text-fig 2. The Fermentation of Tan-bark.—Daily Yields of Carbon Dioxide. Unbroken line = test, broken line = control.

A slight increase on the tenth day followed the addition of the alkali, but on the eleventh day the yield went down. This suggested that the amount of alkali had not been enough, and accordingly 10 c.c. of N/1 sodium hydrate were added to each flask. This quantity seemed to be about right for the yield of gas began to rise immediately. Thus the thirty grams of dry bark required an amount of alkali equivalent to 16.4 c.c. of normal sodium hydrate to neutralise the inherent acidity or, at any rate, that part of the acidity which hindered the fermentative activity of the bacteria. This is equivalent to 54.7 c.c. of normal alkali per 100 grams of dry bark.

The control remained sterile until the last addition of soda. Apparently the spores had not been destroyed by the heat sterilisation and had remained quiescent until conditions of growth were made favourable by the alkali. The vegetating bacteria added to the test at the start remained in the acid bark for some time, but they slowly disappeared for on the twelfth day they were very few in number

* This contained 0.22 milligrams of CO_2 as impurity.

compared with earlier examinations. So pronounced was this that the flask was reseeded on the thirteenth day, with the same race, 80.

When the bacteria appeared in the control, 0.5 gram of crystal violet was added and this caused a sharp fall in the evolution of gas. The activity of the bacteria had been checked and the carbon dioxide that appeared on the fourteenth day may be looked upon as partly residual and partly chemical. The disinfectant did not destroy all the bacteria, but it seemed to hold them in check. On the nineteenth day living bacteria were still in the control flask and on the twentieth day 0.5 gram of mercuric chloride was added.

The rise on the fourteenth day was followed by a fall on the fifteenth and as the yield remained steady for another day, it was considered that a further addition of sodium hydrate might be made. Five c.c. of normal soda were added to each flask and although this caused a slightly increased evolution of gas yet the increase was so little that a further 10 c.c. of soda were added. The yields remained almost constant for several days, and the conclusion was made that the amount of alkali added up to the eleventh day, viz., the equivalent of 16.4 c.c. of normal sodium hydrate was sufficient for the 30 grams of bark. On the twentieth day it was considered that the experiment had reached an end and, as a final cast, it was decided to try the influence of the addition of a nitrogenous nutrient. The previous experimental evidence was in favour of asparagin, and accordingly 0.25 gram was added to each flask.

The effect of the asparagin was very marked and clearly indicated the necessity of the addition of a nitrogenous nutrient for a very active fermentation of tan-bark. There is, of course, the possibility that the carbon of the asparagin was quickly oxidised to carbon dioxide and the increase was derived from the asparagin directly. If this were the case, the 0.25 gram of asparagin is capable of giving 333 milligrams of CO_2. Before the addition of the asparagin, the evolution of CO_2 had been fairly constant at 55 milligrams. During the eight days following the addition, the excess over the 55 milligram mark totalled 623 milligrams, which is more than could be credited to the asparagin. It follows that there is an insufficiency of nitrogen in the bark for its complete fermentation.

An experiment with tempered bark, and parallel to the last with tan-bark, was started one day later. During sterilisation, the temperature, starting at 164°, rose in an hour to 200°, then fell gradually to 176° by the end of the second hour. Thirty grams of the bark dried at 130° were taken for each portion. Fifty c.c. of water containing a suspension of race 80 were added to the test flask and the same quantity of water to the control.

Evolution of Carbon Dioxide from Tempered Bark.

Days.	Control. Milligrams of CO_2.		Test. Milligrams of CO_2.	
	Daily	Total	Daily	Total
1	156	156	180	180
2	104	260	125	305
3	90	350	103	408
4	107	457	104	512
5	71	528	70	582
6	56	584	65	647
10 c.c. N/10 NaOH added.				
7	45	629	63	710
8	44	673	53	763
10 c.c. N/1.85 NaOH added.				
9	38	711	41	804
10	37	748	37	841
10 c.c. N/1 NaOH added.				
11	35	783	51	892
12	45	828	58	950
13	35	863	65	1015
5 c.c. N/1 NaOH added.				
14	26	889	58	1073
15	29	918	41	1114
16	35	953	35	1149
10 c.c. 5N/1 H_2SO_4 added.				
17	24	977	27	1176

The behaviour of this experiment was very much the same as the preceding; it was started a day later. There was a greater evolution of gas, both in the test and the control, which showed that tempered bark is undoubtedly better than raw tan-bark for the production of carbon dioxide. On the tenth day bacteria were found in the control and 0.3 gram of iodine was added on the eleventh day, but this did not destroy the bacteria, for slopes smeared on the thirteenth day grew a good crop of cells. As crystal-violet had checked the bacteria in the tan-bark control, 0.5 gram was added to this control. The addition of the 10 c.c. of N/1 sodium hydrate did not have the same effect as with the tan-bark from which it would seem that either too much or too little had been added. As the latter seemed more likely, 5 c.c. of N/1 sodium hydrate was added to each flask. This caused a fall and, as there seemed to be no likelihood of further information being obtained by continuing the experiment, 10 c.c. of dilute sulphuric acid (= 5 N/1) were run into each flask. The small yield of CO_2 following this treatment showed that all the alkali previously added had not fixed any appreciable amount of carbon dioxide.

On the whole the experiment was far from satisfactory on account of the non-sterility of the bark and especially of the control. The earlier high yields from the control, which were considered to result from a chemical oxidation, were, in view of a later experiment, the product of the activity of bacteria entrapped in the pores of the bark fragments. The sterilisation of the bark is an exceedingly difficult matter.

The loose water in the control flask was found to be sterile when tested on the second and fourth days, but the presence of the bacteria on the tenth day, when taken in conjunction with the amount of carbon dioxide evolved during

the first few days, suggests that the bacteria were actively fermenting while held in the pores of the bark. A later experiment with tempered disinfected bark yielded 82 milligrams of CO_2 in three days as against 250 in this experiment.

The addition of sodium hydrate to neutralise the inhibiting acidity of the bark seemed to be faulty; there was too much of the hit or miss method about it and one would like to get a more definite process. Some years ago, I showed that the organic matter of rotted leaf-mould could absorb alkali from solutions and there was a difference in its action upon the bicarbonates of the earths and the hydrates. Calculating upon 100 grams of dry ash-free leaf-mould, it was found that about 100 c.c. of normal alkali were taken up from the bicarbonates and about 450 c.c. from the hydrates. Thus there were two kinds of acidity. If there are two kinds of acidity in the tan-bark, it is probable that it is the kind which can decompose the bicarbonates that inhibits the growth of the bacteria.

More definite information regarding the base-absorbing power of the barks was obtained by placing two grams of dry bark in a bottle with 150 c.c. of N/10 baryta water and testing the loss from day to day. A similar test was made with magnesium bicarbonate. The numbers that follow are the c.c. of normal alkali absorbed by 100 grams of the dry bark.*

Baryta absorbed:—

Days	1	2	3	4	5	6
Alley-bark	433	457	474	476	485	491
Tan-bark	391	415	426	433	440	448

Magnesium bicarbonate absorbed:—

Days	1	2	5
Alley-bark	135	136	138
Tan-bark	52.5	70	73.5

The amount of alkali absorbed by the tan-bark from the bicarbonate in one day is close to that which was added in the fermentation test by the twelfth day, viz., 16.4 c.c. for 30 grams, which is equivalent to 54.7 c.c. of N/1 for 100 grams. This seems to be the optimum quantity required for a good fermentation because, when more was added on the sixteenth and seventeenth days, there was practically no further increase in the production.

In the first fermentation experiment with tan-bark (p. 85) the alkali added was equivalent to 18.5 c.c. N/1 for 24 grams of bark, i.e., 77 c.c. for 100 grams.

A second fermentation experiment was made with alley-bark. In the first experiment the alley-bark had been heated to from 164° to 200° for two hours and this was not sufficient to sterilise it. In this experiment, it was heated to 176° and in half an hour the temperature rose to 205°, from which it slowly fell to 186° in two hours; it remained at this for another hour. In order to make sure that the control at least would be sterile, 50 c.c. of 1 % mercuric chloride in 1 % sodium chloride were added and 50 c.c. of water were put into the test flask. Each flask contained 30 grams of alley-bark dried at 130°. As the barks did not wet readily, the flasks were steamed for an hour on the following morning and subsequently remained at laboratory temperature (26°) for five days when space was available in the thermostat. The flasks were connected up and kept at 60° until any mechanically fixed CO_2 might be eliminated before the test flask was seeded with bacteria. The difference in the

* The dry tan bark contained 4.42 % and the alley bark 11.74 % of ash.

amounts of CO_2 evolved, however, indicated that the test bark was probably not sterile, and an examination on the second day showed that this was the case. The gas-forming rod with terminal spore was found, not in the loose water, of which there was very little, possibly 2 c.c., but in the fragments of bark and it was only in contact with these that growth occurred on the agar slopes. The control bark was sterile. There was no need to seed the test flask for it already contained the active organisms.

The amount of CO_2 given off from the test was considerable and this without the addition of alkali or other substance. The small amount given off from the control, showed that what had previously been considered to be a chemical production of CO_2 was in all probability largely due to the activity of the bacteria in the supposedly sterile but actually non-sterile bark.

After the gas from the test flask reached the peak on the third day, the yield slowly fell and, on the sixth day, it was considered that the experiment had shown all it could under the conditions.

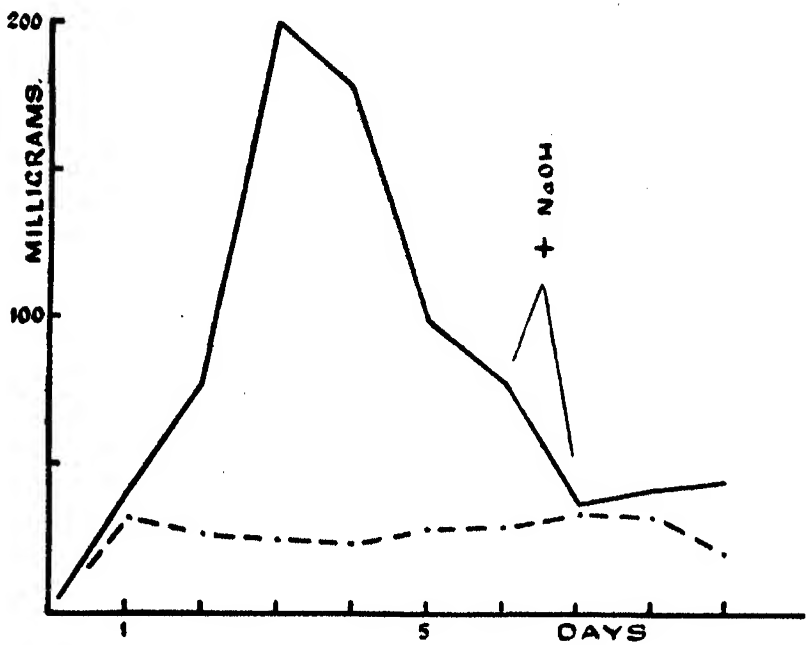
In the first experiment with the alley-bark, the addition of sodium hydrate had led to no increase in the evolution of CO_2, a circumstance which was in marked contrast with the tan-bark. The barks undoubtedly look different, and the alley-bark is more of the nature of charcoal, being black and brittle. Chemically the alley-bark absorbs more alkali from the earthy bases and bicarbonates than tan-bark and, if the fermentation of the latter is influenced by the addition of alkali, the alley-bark should also be favourably assisted. The inactivity of the alkali in the first experiment was peculiar, but possibly there had not been enough added. The tan-bark was favourably influenced by three-quarters of the alkali capable of being absorbed from bicarbonate in five days. In the same ratio, 30 grams of alley-bark should be influenced by 30 c.c. of normal alkali and it may be that the amount added in the first experiment, viz., 16.4 c.c., was not enough to produce any effect. But as 30 c.c. seemed a large quantity to add, it was decided to add 25 c.c. of N/1 sodium hydrate to each flask and see what happened.

Nothing did happen; the yield continued to fall. Next day a further 5 c.c. of sodium hydrate was added, making the total alkali in each flask 30 c.c. Two days afterwards the experiment was concluded as no increase in the CO_2 production had ensued. We must conclude that alley-bark is not influenced by the addition of sodium hydrate and differs from tan-bark in this respect. The control on the 7th day was sterile, while the test was replete with living bacteria.

Evolution of Carbon Dioxide form Alley-bark.

Days.	Control. Milligrams of CO_2.		Test. Milligrams of CO_2.	
	Daily yield.	Total.	Daily yield.	Total.
1	32	32	41	41
2	26	58	77	118
3	24	82	199	317
4	23	105	177	414
5	28	133	99	533
6	29	162	78	611
25 c.c. N/1 NaOH added.				
7	33	195	36	647
5 c.c. N/1 NaOH added.				
8	32	227	41	688
9	20	247	44	732

The experiment showed that the bacteria can actively decompose some constituent of alley-bark with evolution of CO_2 and that it is practically impossible to destroy the resistant cells (spores) by dry heat ranging from 186° to 205°.



Text-fig. 3. The Fermentation of Alley-bark. Daily yields of Carbon dioxide. Unbroken line = test, broken line = control.

Some stack-bark was dried at 130° and portions weighing 30 grams were put into two flasks. Fifty c.c. of water were added to the test and 50 c.c. of 1 % mercuric chloride in 1 % sodium chloride to the control. Both were steamed for an hour on three successive days and were then connected up in the thermostat at 60°. No attempt was made to sterilise the bark with dry heat, and it was not seeded, as it was considered that the spores would be alive. Later films and growths showed this to be the case. The following shows the amount of carbon dioxide given off daily:—

Evolution of Carbon Dioxide from Stack-bark.

Days.	Control. Milligrams of CO_2.		Test. Milligrams of CO_2.	
	Daily.	Total.	Daily.	Total.
1	26	26	28	28
2	24	50	68	96
3	23	73	263	359
4	22	95	231	590
5	23	118	142	732
6	23	141	96	828
7	24	165	111	939
8	21	186	93	1032
added 10 c.c. water				
9	23	209	176	1208
added 10 c.c. water				
10	23	232	125	1333
11	22	254	75	1408
added 0·25 grams asparagin in 10 c.c. water				
12	48	302	166	1574
13	30	332	114	1688
14	31	363	113	1801
15	29	392	81	1882
16	25	417	62	1944

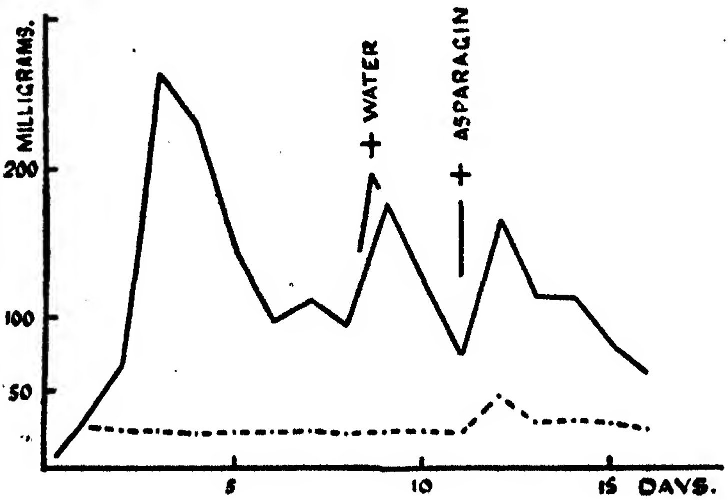
On the 8th day, the control was found to be sterile and the test to contain the stout rods with terminal spores. Although the neck and shoulders of the flasks showed water droplets, the barks themselves seemed to be rather dry and it was considered advisable to add some water. The idea was to add a solution of asparagin, but this was deferred on account of the appearance of the barks. They had become too dry, for 10 c.c. of water caused the yield of carbon dioxide to go up. By the 11th day the action had slowed down and 10 c.c. of water containing 0.25 gram of asparagin were added to each flask.

The asparagin increased the yield of carbon dioxide but not to the extent that the earlier experiment with tan-bark had led one to expect. But it was certainly curious that the asparagin should increase the gas in the control. This was unexpected and leads one to think that perhaps the control bark was not completely sterilised by the mercuric chloride added in the beginning. It is possible that some parts of the bark missed the action of the disinfectant and, if this is the reason, we must consider that the comparatively small yield of carbon dioxide by the control may be due, not to a chemical oxidation, but to a restrained bacterial fermentation. Tubes of saccharose media rubbed with fragments of the control bark gave no growths so that, as far as one can judge, the bark was sterile.

The experiment showed that 30 grams of dry stack-bark, when fermented with the native bacteria, gave off an excess of 1.25 grams of carbon dioxide in 11 days, and with the addition of 0.25 gram of asparagin a further excess of 0.37 gram in 5 days.

A fermentation experiment was made with viscose and Uschinsky's solution, but no carbon dioxide was given off during three days. A small quantity of

sodium hydrate was then added, but this had no effect. Upon investigating the matter it was found that Uschinsky's solution did not serve as a medium for growing the bacterium, and its inability to feed the organism could not be



Text-fig. 4. The Fermentation of Stack-bark. Daily yields of Carbon dioxide. Unbroken line = test, broken line = control.

traced to any one constituent. It had previously been found that a solution similar to Uschinsky's, but containing 1 % of dextrose and 0.3 % of potassium citrate, promoted the growth so that the presence of citrate or a soluble source of carbon is essential.

Meanwhile another fermentation test had been started with 25 c.c. of a modified Uschinsky's solution* and 4 grams of cotton wool that had been disintegrated by heating at 160° to 200°, until it could be rubbed into a fine powder.

No gas was given off in two days, so 5 c.c. of a 3 % solution of potassium citrate was added.

The citrate did not alter matters, for during the following two days, no gas was given off. This showed that in the earlier experiment, the growth and gas production depended, not on the citrate, but on the sugar.

So far the bacterium seemed incapable of attacking cellulose, but before closing the experiment it was thought advisable to see if, after a start had been made with extract of bark, the bacterium would attack the disintegrated cotton. Accordingly an extract was made by steaming 200 grams of alley-bark with 400 c.c. of water for an hour and filtering the extract, first through paper, then through porcelain. Ten c.c. of this were added to the test; the old control was thrown out and another prepared having everything the same as the test, excepting the 4 grams of cotton.

* Asparagin 0.5 %, sodium chloride 0.3 %, magnesium sulphate cryst. 0.2 %, and monopotassium phosphate 0.2 %.

Experiment with Cellulose and Bark-extract.

Days.	No cellulose. Milligrams of CO_2. Daily	Total.	Cellulose. Milligrams of CO_2. Daily	Total.
1	0	0	0	0
+ 1 c.c. N/10 NaOH.				
2	11	11	8	8
+ 1 c.c. N/1 NaOH.				
3	1	12	1	9
4	1	13	31	40
5	0	13	16	56
6	0	13	7	63
7	0	13	5	68

One cannot say very much about this experiment for with 0.25 gram of asparagin and 4 grams of cellulose there should have been much more gas given off, and it would therefore appear as if the carbon dioxide had been derived from the bark extract. On the sixth day, the liquid control did not appear to have much bacterial growth although it contained active bacteria. The test flask contained a sodden mass of cotton with very little loose water. Both had the same slightly alkaline reaction to litmus and phenolphthalein papers. It is possible that if no alkali had been added on the second day the results might have been different.

Conclusions.

There are many points connected with the fermentation of the barks yet to be determined, but so far as the investigation has gone, certain facts have been elucidated. The active agent is a spore-bearing rod with an optimum temperature of 60° C. for laboratory work. It is capable of fermenting the spent wattle-bark of tanneries after the bark has been treated or "tempered." The tempering is undoubtedly a mixed fermentation and in it a temperature of from 40° to 50° is attained. Its object is to maintain a vigorous growth of the active bacteria, but incidentally a certain destruction of the organic matter by moulds, yeasts and bacteria probably occurs. Raw tan-bark which has been heated to a sterilising temperature is not easily fermented by the bacteria and it is probable that this is caused by the inhibiting action of the residual tannin products, because treatment of the heated raw bark with alkali and air so alters the bark that fermentation can ensue. Tests have yet to be made upon unheated raw bark, but it is likely that it will behave similarly to the heated bark. Heated tempered bark is easily fermented and is not influenced by treatment with alkali and air.

It will be remembered that when the stack is built, one part of new bark is mixed with four parts of tempered bark and when the stack is drawn the new bark is found to have been altered in character. It has become black and non-fibrous, indicating that some change has occurred and, as the bark is now easily fermentable, the assumption is that the long fermentation has, among other things, destroyed the inhibiting bodies, be they tannins or others.

In the stack there is a comparatively slow and prolonged evolution of carbon dioxide which is mainly, if not entirely, due to a bacteriological fermentation while the speed of the fermentation seems to be regulated by the small amount of nitrogenous matter in the bark. Were it to be mixed with some substance of a nitrogenous nature, there is no doubt that the production of carbon dioxide would be much more rapid. This was shown by the influence of asparagin in one or two experiments.

The organism is peculiar in some respects. It is capable of decomposing sugar such as dextrose or saccharose when freshly isolated, but soon after it requires the addition of alkali to enable it to act. There are some points yet to be determined regarding its viability, for the vegetative forms rapidly die off under certain, as yet uninvestigated, conditions. The spores are very difficult to destroy, especially when they are contained in the pores of the bark; they were alive after an exposure to 186° to 205° for two and a half hours.

While the bacteria can decompose tempered bark and stack-bark and also raw tan-bark after it has been treated with alkali, we are not quite sure if they are capable of fermenting cellulose such as disintegrated cotton-wool. When they were tested with this there was not enough carbon dioxide given off to warrant the conclusion that the cellulose had been attacked.

There was no growth of the organism in media devoid of soluble sources of carbon such as Uschinsky's solution. On the other hand there was growth and gas formation in similar solutions containing sugar. Thus the constituent of the bark that is fermented is still unknown.

SUMMARY.

The fermentation of spent wattle-bark in the corrosion of white lead is caused by a stout rod-shaped bacterium having a terminal spore. Its optimum laboratory temperature is 60° C., although in the corroding stacks the temperature may rise to 80°.

Raw spent wattle-bark is difficult to ferment and requires a preliminary treatment. As conditions which oxidise tannin substances favour the fermentation of the raw bark, it is probable that the residual tannins inhibit fermentation.

I am indebted to Lewis Berger and Co., Ltd., for a supply of bark, and to Mr. H. J. Sullivan, of the Company, for notes upon the manufacturing process. I am also indebted to Mr. W. W. L'Estrange for much kindly assistance.

AUSTRALIAN FRESHWATER FLAGELLATES.

By G. I. Playfair.

(Plates i. to ix.; and three Text-figures.)

In the present paper I have endeavoured to give some account of all those forms of microscopic life found in our waters, which are included under the class Flagellatae of the freshwater Algae. From the early days of my studies I have always felt a lively interest in the freshwater flagellates and looked forward to a time when I should be in a position to set forth some small attempt at a monograph of such as occur locally. The following notes therefore, dealing with almost all the commonly occurring species and with a large number of forms, also, which are not at all common, represent the gleanings of 15 years.

The more important part of the work, however, was accomplished during the period when, as a science research scholar of the University of Sydney, I was enabled to devote myself for some years to a more thorough investigation of Australian pond life than I had previously done. It is with pleasure, therefore, that I here express my heartiest gratitude to the Senate of the University for afforded me the opportunities which have resulted in my bringing a long-cherished desire to a successful issue.

In conjunction with these notes should be taken my earlier paper on "The Genus *Trachelomonas.*" (These Proceedings, xl., 1915) which was written in advance, on account of the very large number of new forms observed in that genus. The title "Australian Flagellates" may perhaps be considered too grand when it is observed that all the gatherings were made in two localities only, viz.: —the suburbs of Sydney and the neighbourhood of Lismore. This, however, is not so, for the Flagellates are entirely cosmopolitan and the ordinary forms always very wide-spread. In moving from one district to another one merely picks up the same common form over and over again. The rarer varieties, on the other hand, are generally polymorphic forms without any local attachment whatever, but merely the result of unusual combinations of rain and shine, temperature, movement and stagnation in their habitat. It is for this reason that they are uncommon. They are entirely the product of their environment. In a very large number of cases also, they are simply stages of growth which have become fixed at that point either by the induration of the cell-wall or by the lack of any stimulus to further growth.

Given a suitable district the most advantageous course to pursue is to thoroughly exploit its treasures over a term of years, by repeated gatherings from every little pond, roadside puddle, or piece of swampy ground. All the forms marked "Lismore" in this paper were gathered within a circle no more than 2 miles in diameter, and yet after my having thoroughly ransacked this comparatively small area for eight years, two fine specimens, never previously recorded—*Mallomonas litomesa* Stokes and *Trachelomonas splendida*, n.sp.—make their appearance from pools already well searched (March, 1920). Compare my remarks in "New and rare freshwater Algae" (These Proceedings, xliii., 1918, p. 498). *Trachelomonas splendida* was obtained from the pool there referred to.

Mention is here made of 172 forms of flagellate life representing 39 genera; 105 being classed as species, 62 as varieties and 5 forms. Of these, 43 species, 48 varieties and 5 forms (96 in all) are considered to be hitherto undescribed. One genus, *Scintilla*, is proposed as new.

These figures, however, do not include the 104 forms of *Trachelomonas* previously recorded. When these are added, the total number of non-Volvocine Flagellates observed to date, stands at 276. The proportion of new forms may appear rather large, but it should be borne in mind that hardly any work has been done on the freshwater Flagellates of subtropical or tropical countries, and that it is exactly the higher temperatures prevailing there and the greater vicissitudes to which pond life is subjected, that are the cause of the much larger number of varieties to be observed.

The enlargement attached to the figures in the explanation of the plates is not the magnification used in observation of the living specimens but merely indicates the scale (somewhat reduced) used in drawing the figures for reproduction. Observations were made chiefly with a 1/6 inch holoscopic objective, N.A. .95, and 18 diam. ocular in a tube-length of 6 inches. These were assisted by a 1/12in. homogeneous holoscopic lens.

FLAGELLATAE

Protomastigineae.

Fam. BICOECACEAE.

Genus POTERIODENDRON Stein.

POTERIODENDRON PETIOLATUM Stein (Pl. i., fig. 1).

Lorica long. 17—22, lat. 8—11μ.

Guildford (77); Lismore (260, 290, 298).

Stein, Der Organismus der Infusionsthiere, iii., H.i., T.xi., fig. 8–11; Senn, Flagellata, p. 123, f. 80; Kent, Infusoria, *Stylobryon petiolatum* (*non* Dujardin), Pl. xxiii., fig. 17—30; *Dinobryon petiolatum* Lemm., Gattung *Dinobryon*, p. 519.

The cupule has a slightly everted rim. I have never seen the zooid, but small sprays of the empty cupules occur very sparsely in my gatherings. They are generally faintly rufescent, differing in this from all forms of *Dinobryon*, the petioles inconspicuous and no longer than the cupules, so that the latter appear to be sessile. They may always be distinguished from *Dinobryon* by a minute refringent blob at the base, marking the head of the petiole which is there slightly dilated. Main petiole of a spray noted—55μ long. For *Stylobryon* Fromental (*see* Kent, *l.c.*, Pl. xxiii., fig. 29) the arrangement of the cupules in

the figure differs from both *Dinobryon* and *Poteriodendron*. *Dinobryon petiolatum* Duj. (Hist. Natur. des zoophytes Infusoires, p. 322, T.i., fig. 22) has nothing to do with *Poteriodendron*, as the author says "animaux verts."

Var. ABBOTTI (Stokes) mihi. (Pl. i., fig. 2.).

Cupules conical-campanulate, rim not everted, dimensions same as those of the type.

Sydney Water-Supply; Lismore (260, 290).

Syn. *Stylobryon Abbotti* Stokes, Infusoria of the U.S., p. 79, Pl. i., fig. 12; *Dinobryon sertularia* forma, Playf., Plankt. Syd. Water, p. 515, Pl. 57, fig. 5; *D. sertularia* var. *conicum*, Playf., Frw. Alg. Lismore, p. 315; *Cf.* Stein, *l.c.*

Stokes gives a good detailed account of this form and its zooid, but his figure is incorrect, as he says that the cupules are twice as long as the maximum breadth (true also of Stein's and of our own) whereas in fig. 12 the proportions are only 6:5. I find the two forms intermingled in the same spray.

Fam. CRASPEDOMONADACEAE.

Genus SPHAEROECA Lauterborn.

SPHAEROECA VOLVOX Lauterborn.

Coenob. diam. c.15μ; cell. long. circa 5, lat. c. $\frac{3}{4}\mu$. Lismore.

Cf. Senn, *l.c.*, p. 126, f. 84B (after Lauterborn). Very rare, only once noted as a minute coenobium of hyaline cells radiating from a centre as in *Synura*. The cells were so small and the outlines so indistinct that even under a high magnification I was unable to make out the details. Senn gives the dimensions as, cells 8—12μ long, coenobium up to 200μ.

Genus SALPINGOECA Clark.

I do not think that there is anything characteristic of the species in the presence, absence or length of the petiole in this genus. Kent's figures, *l.c.*, Pls. v. and vi. seem to me to show this distinctly. Pl. v., f. 20, makes it quite clear also that the coenobium may simulate *Petiolatum* so that in the absence of the zooid one cannot be distinguished from the other.

SALPINGOECA AMPULLACEA (A. Br.) Stein. (Pl. i., figs. 3, 4).

Cell. long. 10, lat. $4\frac{1}{2}$—$6\frac{1}{4}\mu$. Lismore (302).

Syn. *Chytridium ampullaceum*, A. Braun, "On Chytridium," T. v., f. 24—27; Stein, *l.c.*, iii., H. i., T. xi., f. 6, 7. Quantities noted on one occasion on *Oedogonium*—rare, however, in my experience. Kent's figures of *S. amphoridium*, *l.c.*, Pl. v., f. 2, 5, at least, should be considered as representing this species, the long narrow tubular neck being characteristic. A minute peduncle may sometimes be observed and is probably very often present when not noticeable.

Var. CORDATA, n. var. (Pl. i., fig. 5).

Loricae corpore cordiforme nec globoso, inferne acuminato, lateribus levissime arcuatis. Long. 10, lat. $4\frac{1}{2}$—$6\frac{1}{4}\mu$. Lismore (302). Cum forma typica.

The body of the lorica is more or less heart-shaped, not globose, and runs to a point beneath. Kent describes and figures (*l.c.*, Pl. v., figs. 13—16), species *S. amphora* Kent and *S. urceolata* Kent, of somewhat similar shape, but without the long neck. On *Oedogonium* in quantity, mixed with the type.

Salpingoeca amphoridium Clark.

If I say that I do not know whether I have ever observed the type of this species, it is because Clark's original figures (Ann. Mag. Nat. Hist., Ser. iv., vol. i., 1868, p. 203) are difficult of access, the figures given by various authors all differ among themselves and, though typical forms are distinct enough, it is not always easy to say where *S. amphoridium* ends and *S. ampullacea* begins.

Lately, however, I have obtained good pencil sketches of Clark's type figures. He gives two, which are not in the least alike. The second has never, to my knowledge, been observed or figured since, and as it is far the most common form of *Salpingoeca* in this country, I have adopted it as var. *australica* (*infra*). The other is nearly, but not quite identical with Kent's figures (Infusoria, Pl. v., figs. 3, 4, and 7 only, especially fig. 4)—this, therefore, must be considered as the type. It has an almost exactly globose body, rounded below, somewhat produced and ovate above, but very little narrowed or constricted in the throat, the sides diverging upwards and outwards straight to the wide mouth, rim not everted. There is no distinct tubular neck. Kent's figures are all too narrowly constricted and some verge on *S. ampullacea.*

Var. australica mihi. (Pl. i., fig. 6).

Cellulae minutae, sessiles; inferne rotundatae, superne ovatae, haud vel levissime constrictae, lateribus ad os convergentibus, ore non everto, collo nullo vel haud distincto.

Cell. long. 8—14, lat. 4—6, lat. oris 1—2μ.

Auburn; Guildford; Casino (189); Lismore (254, 260).

Our commonest form; found sessile on *Spirogyra, Hydrodictyon, Oedogonium,* more rarely on *Cyclops* (Entomostraca). The cells are ovate, rounded below, narrowed above, sides converging to the narrow mouth, only very slightly constricted, if at all, therefore with no formation of throat or neck except the very least straightening of the sides below the mouth, rim not turned out. Senn's figure of *S. amphoridium,* Flagellata, p. 128, fig. 85A (*after Francé*), has the same shape of opening as var. *australica,* but below is very strongly inflated, much more so even than in Clark's type. It might stand as var. *Francei.* Butschli's form with flat base, figured by Kent (*l.c.,* Pl. v., fig. 33) should rather, on account of the distinct neck and everted rim, be considered a variation of *S. ampullacea.*

Salpingoeca steinii Kent. (Pl. i., fig. 7).

Syn. *S. amphoridium* Stein (*non* Clark), *l.c.,* T. xi. f. 1—5. This form might well have been arranged as a variation of *S. amphoridium.* The lorica has the same characteristic wide mouth and throat but no neck. The body, however, instead of being globular, is drop-shaped with a minute protuberance beneath, acting as a peduncle.

Cell. long. 21; lat. corp. 7, constrict. $2\frac{1}{2}$, oris 5μ.

Fairfield (112). Out of weeds in a creek pool.

Salpingoeca oblonga Stein. (Pl. i., figs. 8, 9).

Cell. long. 11—16; lat. $4\frac{1}{2}$—6, lat. oris $3\frac{1}{2}$; stip. long. 4—5μ.

Guildford (77, 88); Lismore (260).

Cf. Stein, *l.c.,* T. x., fig. iv., 4. Zooid not observed. Stein's figure works out at long. corp. 21, lat. $7\frac{1}{2}$; stip. long. 9μ. Very rare here and position some-

what doubtful—it might be a form of *Poteriodendron*. Out of weeds in a creek pool, along with *Dinobryon* and *Poteriodendron*.

Fam. PHALANSTERIACEAE.

Genus PHALANSTERIUM Cienkowski.

PHALANSTERIUM CONSOCIATUM (Fres.) Cienk. (Text-fig. 1*a*).

Coenob diam. 100—440μ.

Auburn (140, 149); Rookwood; Lismore (308).

Cienkowski, Beitr. z. Kenntn. mikrosk. organismen; Kent, Infusoria, Pl. xii., f. 5—9; Stein, *l.c.*, T. vii., fig. 1, 2. Generally met with in ground gatherings in swampy places. It occurs as irregularly circular or oval cushions with scalloped edges, consisting of a pale yellow or brownish mucus, minutely granular. In optical section at the edges the cushion shows as composed of a series of radiating wedges, each containing two cells near the margin. From above, the structure is irregularly polygonal.

Fam. MONADACEAE.

Genus DENDROMONAS Stein.

DENDROMONAS VIRGARIA Stein. (Text-fig. 2*e*).

Naturg. d. Flagell., H. i., T. vi., fig. 1—5. Very rare, noted only once, from the Richmond River at Lismore (186) as a spray of a large number of living cells, the latter 10 × 8μ, agreeing in shape with those figured by Stein. Differs from *Anthophysa* in having a delicate branched coenobium, each cell being fixed at the end of a separate branch; *cf.* Senn. *l.c.*, p. 133.

Genus ANTHOPHYSA Bory.

ANTHOPHYSA VEGETANS (O. F. Muller) Stein.

Coenob. diam. 24—28; cell. long. 12, lat. 4—6μ.

Auburn; Parramatta; Lismore (253, 260, 263).

Cf. Stein, *l.c.*, T. v., fig. 1—17; Senn, *l.c.*, p. 133, fig. 89c. This organism consists of a cluster of cuneate cells attached to stones or weeds by a very irregular mucous peduncle which gets gradually drawn out thinner and thinner by the movement of the flagellate cells until the cluster breaks away and becomes a free-swimming stellate coenobium. The shape of the cells seems to vary from pyriform to cuneate, generally the latter as far as my observation extends.

Genus CEPHALOTHAMNIUM Stein.

CEPHALOTHAMNIUM CYCLOPUM Stein. (?) (Text-fig. 2*f*.)

Long. corp. 10, lat. 3; long. stip. 10; long. flag. c. 20μ.

Canley Vale (128).

A few single zooids noted on the shell of an entomostracan.

They were hyaline and perhaps represent this species. Of course, each coenobium must begin with a single stipitate or sessile zooid. Cf. *Cephalothamnium caespitosum* Kent and *C. cuneatum* Kent; also *Anthophysa stagnatilis* Stokes, p. 83, Pl. i., f. 16, 17.

Fam. BODONACEAE.

Genus Bodo Ehr.

Bodo edax Klebs. (Pl. i., fig. 10).

Flagellatenstudien, Zeitschr. f. wiss. Zool., Bd. lv., 1892. *Cf.* Senn, *l.c.*, p. 135, f. 90A. Oval, more or less flattened on one side, pointed in front, rounded behind, with two distinct flagella near the anterior end, one at least, if not both, often directed backwards. A large coloured food ball often noticeable towards the hinder end. Contractile vesicle in front.

Long. 15, lat. 10μ. Lismore. Rare.

Bodo saltans Ehr. (Pl. i., fig. 11).

Cf. Stein, T. ii., Abt. vi., f. 1—7 and Abt. v., f. 15; Kent (*Diplomastix*) Pl. xxiv., f. 11—12; Forbes and Richardson, Biol. Upper Illinois River, Pl. lxxxiii., f. 9 (after Kolkwitz). These authorities all agree in identifying this species with the minute drop-shaped flagellate which is commonly seen under the microscope *pecking* away at any dissolving mass of protoplasm. The body is slightly curved, broadly rounded behind and somewhat pointed in front. Here are attached two, long, distinct flagella which are turned backwards under the animalcule. Occasionally it fastens itself to some rotting organism by its pointed anterior extremity, holding on, no doubt, by the bases of the flagella. *Cf.* Stein, T. ii., Abt. v., f. 12 and f. 15, in which state it has been described as *Colpodella pugnax* Cienkowski.

The figure of *Bodo saltans* given by Senn, *l.c.*, p. 135, fig. 90B, would seem to belong to *Bodo caudatus* (Duj.) Stein, *l.c.*, T. ii., Abt. v., f. 1—14 (*Amphimonas caudata* Duj. *l.c.*, Pl. 7, fig. i.; *Diplomastix caudata* (Duj.) Kent, *l.c.*, Pl. xxiv., f. 1—10; *Heteromita putrina* Stokes, Frw. Infus. U.S., p. 105, Pl. ii., fig. 6, 7.)

Other figures that seem to represent this organism are *Heteromita rostrata* Kent, Pl. xv., fig. 18—28, *H. uncinata* Kent, Pl. xv., fig. 29, and *H. adunca* Meresch. in Kent, Pl. xv., f. 44.

Fam. AMPHIMONADACEAE.

Genus Rhipidodendron Stein.

Rhipidodendron huxleyi Kent. (Text-fig. 1*b*).

Not uncommon in bottom samples from swampy pools. The elegant pale yellow fronds of the coenobium attain to about 250μ in length. The animalcules themselves are minute and inconspicuous cells situated at the tips of the branches. *Cf.* Stein, T. iv.

Auburn; Grafton (265); Lismore (254, 308, 316).

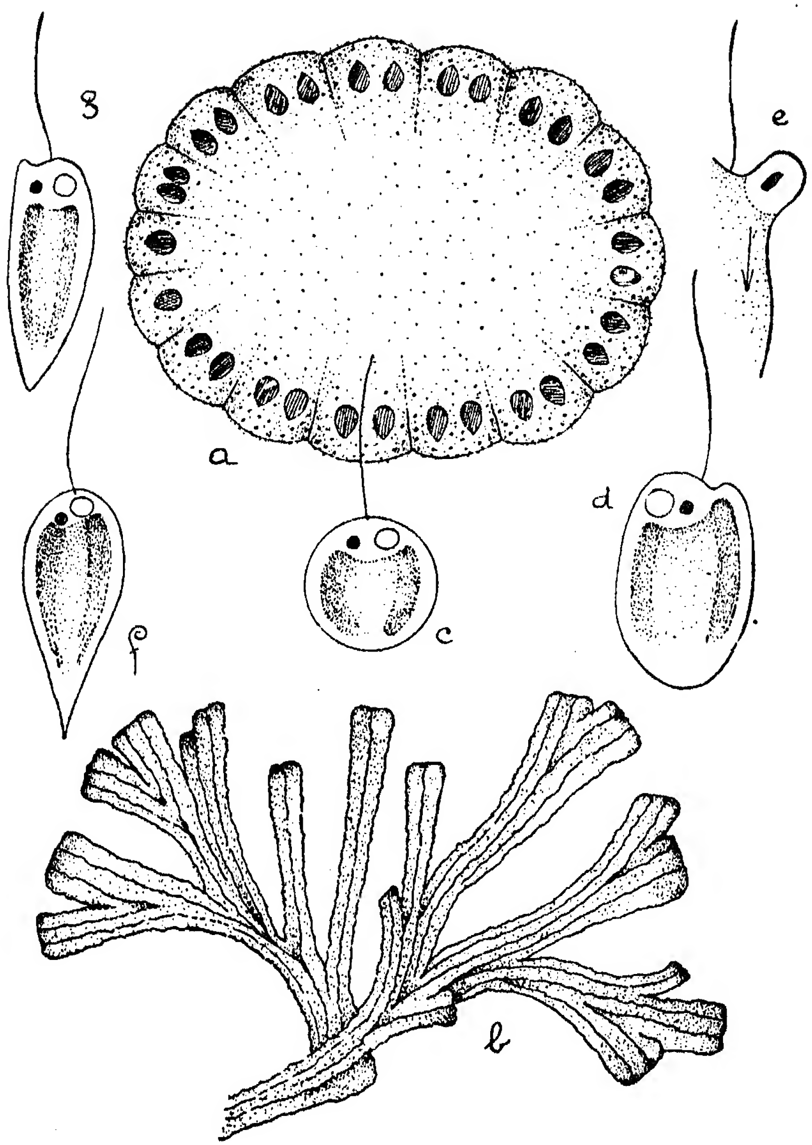
Distomatineae.

Genus Trepomonas Dujardin.

Trepomonas agilis Duj. (Pl. i., fig. 12).

Dujardin, *op. cit.*, p. 294; Senn, p. 149, fig. 103C; Stein, T. iii., Abt. iii., f. 1—14.

Lismore (344). In the water of putrid swamps.



Text-fig. 1.
(a) Phalansterium consociatum (Fres.) Cienk. x 500; *(b) Rhipidodendron Huxleyi* Kent. x 375; *(c) Chromulina ochracea* (Ehr.); *(d) Chr. ovalis* Klebs; *(e) ditto* seizing a *Bacterium*; *(f) Chr. pyriformis*, n.sp.; *(g) Chr. cuneata*, n.sp.; *c–g* x 2000.

Genus HEXAMITA Dujardin.

HEXAMITA INFLATA Duj. (Pl. i., fig. 13).

Dujardin, p. 296; Stein, T. iii., Abt. iv., f. 1—6.

Lismore (344). With the preceding species.

Dujardin gives the length as 17—20μ. What I figure is probably a young form, as the whole front half of the body was homogeneous and transparent, nor did I observe the four anterior flagella which might, however, have been present. The shape was almost quadrangular, rounded and bag-shaped in front, truncate-emarginate behind with distinct angles furnished each with a long flagellum.

Chrysomonadineae.

Fam. CHROMULINACEAE.

Genus CHROMULINA Cienkowski.

CHROMULINA FLAVICANS (Ehr.) (Text-fig. 2 *a*—*d*).

Coenob. diam. 20—60; cell. diam. 8—12μ.

Centennial Park, Sydney.

Syn. *Monas flavicans* Ehr.; *Chrysomonas flavicans* (Ehr.) Stein, *op. cit.* T. xiii., f. 16—19. Very rare, only once observed. Our forms agree perfectly in size and appearance with Stein's excellent figures in Naturg. d. Flagellaten. The dimensions of his figures work out at: coenob. diam. 15—65, cell. diam. 7—10μ. The chromatophores are yellow-green, arranged as in *Synura* and *Mallomonas*. When mature, the cells are globose, but from self-division are generally found more or less oval.

CHROMULINA OCHRACEA (Ehr.) (Text.-fig. 1*c*).

Cellulae sphaericae, diam. 5½—8½μ. Lismore (294).

Minute spherical cells with two yellow-green chromatophores longitudinally and rather irregularly disposed within the cell and not quite parietal. There is a minute stigma and relatively large c.v.

Syn. *Monas ochracea* Ehr.; *Chrysomonas ochracea* (Ehr.) Stein, T. xiv., Abt. iii., f. 1, 2. This and all other forms of *Chromulina* mentioned here were found enmeshed in the mycelium of a fungus surrounding a rotting plant stem floating in swamp waters.

CHROMULINA OVALIS Klebs. (Text-fig. 1*d*, *e*).

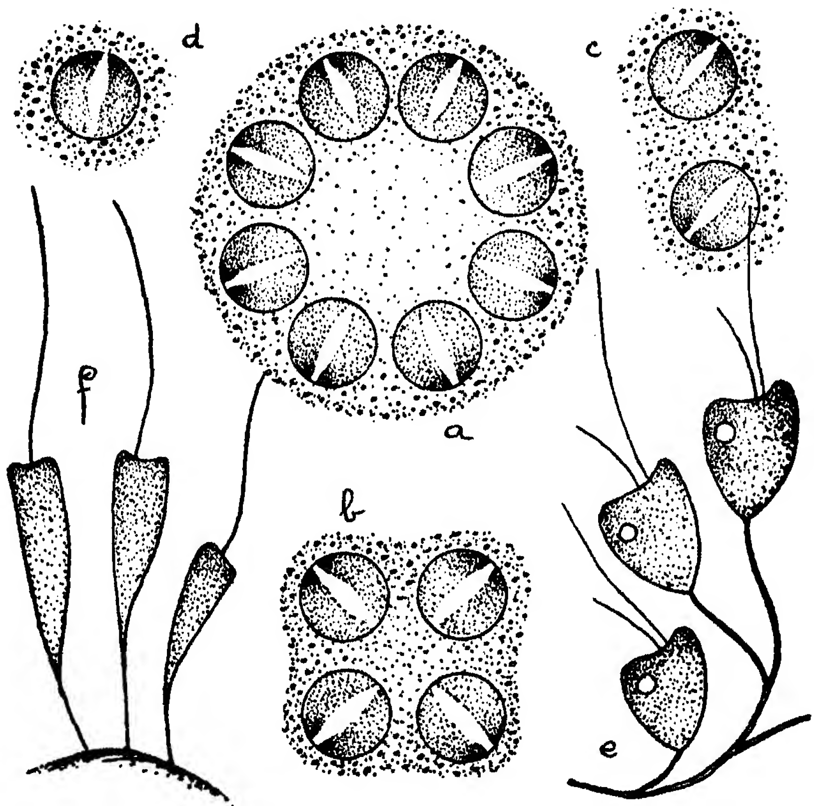
Cell. long. 8½—11½, lat. 5½—7½μ. Lismore (294).

Cf. Senn, *op. cit.*, p. 154, f. 107, B2. Oval or oblong in contour, with a decided nick to one side in front from which the flagellum springs. At this point there seems to be a kind of protrusile or distensible pharynx. I noted one feeding on cells of *Bacterium termo*. These were worked down the flagellum and received with a globule of water (or plasma) which could be observed as a very distinct swelling passing down the side of the cell till it lodged in the posterior part of the cell. Exactly the same procedure is depicted by Senn, p. 119, in the case of *Oicomonas termo* Ehr. which this species of *Chromulina* very much resembles. Is it possible that one is a saprophytic form of the other?

CHROMULINA PYRIFORMIS, n.sp. (Text-fig. 1*f*).

Cellulae plus minus pyriformes, fronte rotundatae, postice acuminatae. Cell. long. 11—12, lat. $5\frac{1}{2}\mu$. Lismore (294).

Cells pear-shaped more or less, or ovate, broadly rounded in front, and pointed behind.



Text-fig. 2.
(a–d) Chromulina flavicans (Ehr.) x 900;
(e) Dendromonas virgaria Stein. x 1500;
(f) Cephalothamnium cyclopum Stein, (?) single zooids, x 2000.

CHROMULINA CUNEATA, n.sp. (Text-fig. 1*g*).

Cellulae prae latitudine longiores, cuneatae; fronte subtruncatae, postice acuminatae.

Cell. long. 12, lat. $3\frac{1}{2}$—4μ. Lismore (294).

The cell is long and narrow, somewhat wedge-shaped, subtruncate in front with a notch to one side as in *Chr. ovalis* Klebs, sharp-pointed behind, sides slightly arched.

Genus MALLOMONAS Perty.

MALLOMONAS ACAROIDES Perty. (Pl. ii., figs. 1, 2).

Cell. long. 21—42, lat. 12—23; setae long. 12—30μ.

Auburn; Guildford (84); Parramatta (136); Clyde; Wyrallah; Lismore (261, 287).

Syn. *Mallomonas Plosslei* Perty, *see* Kent, Pl. xxiv., f. 72, 73; *Lepidoton dubium* Seligo. Many forms of this species may be found, as it is very variable in its growth. I have noted subglobose, oval, ovate pointed in front, ovate pointed behind, elliptic; but probably they are all growth forms of one and the same organism. There is evidence to show that *Mallomonas* develops from a small globose cell, and according to its rate of growth, and the line of development that it takes, so is the resulting form. In every species the fully-developed form is linear-elliptic or oblong-elliptic. In *M. acaroides* also the cell may be furnished all over with setae, or some part of the surface may be devoid of them, or again they may be entirely wanting, and occasionally they are so delicate as almost to escape observation. Cells as low down as 14 × 10μ have been noted. Perty's type is really an immature form of the species, and these may generally be recognised by having the c.v. at the hinder end; in the mature form they are set in a circle at the posterior third of the cell. Compare here *M. elegans* Lemm., Schwed. Gewasser, f. 14, and *M. tonsurata* Teiling, Schwed. Plankt., i., fig. 3.

MALLOMONAS SPLENDENS (G. S. West) Playf. (Pl. ii., fig. 3).

Cell. long. 30—56, lat. 9—13; setae long. 16—36μ.

Auburn; Sydney Water (64, 80, 81); Botany (142); Botanic Gardens (3); Wyrallah; Lismore (241, 260, 261, 316).

Syn. *Lagerheimia splendens* G. S. West, Algae Yan Yean Reservoir, p. 74, Pl. 6, f. 4—8. Judging by my records this species is even more common in our waters than *M. acaroides*, and it is generally found in the mature shape, if not always the full size. Indeed, I know of only one young form (*infra*). There may be any number of setae from 2 to 4 before and behind. They differ from the setae of *M. acaroides*, which are like very fine bristles, in being stouter, of a spinous nature and inflated strongly at the base. Those in front are generally carried at right angles to the body, the hinder group project right back; they are capable of a slight amount of lateral movement.

Var. PUSILLA, n.var. (Pl. ii., fig. 4).

Forma multo-brevior, oblongo-ovalis, setis nullis observatis, membrana glabra, striis obliquis 3—4 decussatim dispositis ornata.

Cell. long. 10—17, lat. 8—12½μ.

Sydney Water (80, 81); Centennial Park, Sydney; Byron Bay.

Probably a young form either in process of growth or fixed by incrassation of the cell wall before reaching maturity. It is much shorter than the type though almost as broad as a full-grown specimen. Oblong-oval in shape, membrane smooth, crossed by 3 or 4, very fine, obliquely disposed, criss-cross grooves having the appearance of striae. No setae in the specimens noted.

MALLOMONAS AUSTRALICA, n.sp. (Pl. ii., fig. 5).

Cellulae elliptico-cylindraceae; mediis lateribus fere rectis; apicibus late-rotundatis. Membrana hyalina incrassata, granulis parvis in seriebus transversis ordinatis ornata; setis nullis notatis.

Cell. long. 20—25, lat. 10μ.

Botanic Gardens, Sydney (3); Botany; Guildford; Lismore (245).

A much rarer species than either of the foregoing. When mature it is oblong-cylindrical with broadly rounded ends, and crossed transversely but not obliquely by rows of small granules. No setae observed.

Var. GRACILLIMA, n.var. (Pl. ii., fig. 6).

Forma gracillima, magis stricte cylindracea; lateribus fere rectis, apicibus rotundatis. Membrana ut in forma typica; setis nullis.

Cell. long. 22, lat. 4μ. Lismore.

Var. SUBGLOBOSA, n.var. (Pl. ii., figs. 7, 8).

Cellulae subglobosae vel ovales, plerumque fronte paullo angustatae; vesiculis contractilibus 4 juxta extremitatem posteriorem; ceteris ut in forma typica.

Cell. long. 21—27, lat. 16μ. Lismore (316), from swampy ground.

These are probably young growth forms of the type, either still in process of development or, as I think more likely, which have become fixed by the hardening of the cell-wall due to stagnation. On either view they give us a glimpse of the life-history of the organism.

MALLOMONAS LITOMESA Stokes. (Pl. ii., fig. 9).

Cell. long. c. 25, lat. c. 5μ. Lismore.

Stokes, Freshwater Infusoria of the U.S., Journal Trenton Nat. Hist. Soc., i., 1888, p. 92, Pl. i., f. 32.

Very rare indeed, only once observed. The body is linear-elliptic, membrane delicate and smooth (Stokes says however "Cuticular surface finely crenulate"), a few straight setae at the hinder end, but those in front are characteristic, being six in number springing from a small membraneous projection and curved back like the ribs of an umbrella. Chromatophores pale yellow-green, close to the cell-wall.

Var. CURTA, n.var. (Pl. ii., fig. 10).

Cellulae curtae, oblongae; pone late rotundatae sine setis; ceteris ut in forma typica.

Lismore, with the type.

This form is very short, oblong, broadly rounded behind where the setae are wanting; otherwise like the type. Size not noted. A narrower and more strictly cylindrical form, much less commonly met with. Sometimes at the anterior end there is a slight membraneous bi-papillate projection, and below the flagellum, just between the ends of the chromatophores, a dark granule may occasionally be distinguished. I have noticed the same in *Synura granulosa*, *cf.* New and rare freshwater Algae, p. 508, Pl. lvi., f. 1—3.

Fam. PHAEOCAPSACEAE.

Genus PHAEOCOCCUS Borzi.

PHAEOCOCCUS PLANKTONICUS W. and G.S. West. (Pl. ii., fig. 11).

Coenob. diam. 90; Cell. diam. 10μ. Botany.

Obtained once only in a ground gathering of mixed microscopic life from Gardener's Road swamps, Botany. It was in the *gloeocystis* condition as a hyaline, structureless, mucilaginous coenobium containing 4 families of about 8 cells each. The cells were globose, with two yellow-brown parietal chromatophores disposed as in *Synura* or *Mallomonas*. Senn has no place for this genus in his "Flagellata"; I include it here from some resemblance to *Phaeocystis*, at least in its vegetative condition.

Fam. SCINTILLACEAE.

Genus SCINTILLA, n.gen.

Cellulae minutae, delicatissime, ovatae vel ovales; membrana tenuissima, glabra, hyalina, granulis nullis nec setis; chromatophoris 2 parietalibus per longitudinem dispositis; flagellis 2 tenuissimis; vesiculis contractilibus 2 postice instructae; stigmate nullo.

SCINTILLA CHLORINA, n.sp. (Pl. ii., figs. 12—14).

Cellulae ovatae subcuneatae, fronte angustiores, postice late-rotundatae; polo anteriori modice deplanatae et saepe levissime emarginatae; membrana delicatissima hyalina glabra; flagellis 2 tenuissimus; chromatophoris 2 luteo-viridibus; stigmate nullo.

Cell. long. 7½—21; lat. 4½—12½μ. Byron Bay (324).

A very rare flagellate which I obtained in some quantity from the drained bog at Byron Bay soon after rain. In shape the cell varies from ovate to subcuneate, narrower in front, well rounded behind, sides often somewhat flattened towards the anterior end, which is subtruncate and slightly emarginate. Membrane very delicate and indistinguishable, smooth, hyaline, without markings or setae; flagella two. The cell contents are arranged as in *Synura* or *Mallomonas* with two, thin, yellow-green, parietal chromatophores disposed longtitudinally, starting in front and gradually developing right back to the hinder end. When the opposite edges of the chromatophores just overlap in the middle there appear to be four longitudinal chromatophores but this is an illusion. The posterior portion of the contents is a clear, transparent, homogeneous mass, generally surrounded by large amylaceous granules; no stigma, but there seem to be two pulsating vacuoles behind. With dilute formalin the cell crumples up at once to a shapeless mass, extruding the contents; this does not occur in *Synura* or *Mallomonas*. It is generally taken to indicate the entire absence of cell-wall, but of this I have my doubts. Cf. *Phaeocystis globosa* Scherffel in Lemmermann (Nord. Plankt., xxi.) Flagellatae, p. 2, f. 6.

SCINTILLA SPLENDIDA, n.sp. (Pl. ii., fig. 15).

Cellulae ovales, polos versus praecipne anteriore modice attenuatae, fronte levissime emarginatae; membrana glabra granulis nullis nec setis; flagellis 2 tenuissimis; stigmate nullo; chromatophoris obscure viridibus.

Cell. long. 31, lat. 19μ. Lismore (347).

This species is half as large again as the foregoing and very different in appearance. It is elliptical-oval, not ovate, but the minute emargination in front may still be noted. The membrane is smooth and hyaline, showing no sign whatever of markings or setae. I examined a specimen with the 1/12th inch homogeneous immersion lens; the internal organisation is exactly as in *Synura* or *Mallomonas*, the anterior third consisting of very finely granular protoplasm, the posterior two-thirds of a globe of clear, transparent, homogeneous material surrounded by large amylaceous granules, the whole being enclosed by two delicate parietal chromatophores. The colour of the latter was very distinct, being neither yellow-green nor chlorophyll-green, nor brownish-green, nor blue-green, but a deep gray-green. Very little reliance, however, can be placed on the colour of the chromatophores in the *Chrysomonadineae* as a study of *Cryptomonas* soon shows. Two very delicate flagella noted, which seems to separate the organism from *Mallomonas;* I was not able to detect the pulsating vesicles, but from 2 to 4 will probably be found towards the hinder end of the cell.

Fam. TESSELLARIACEAE.

Genus Tessellaria Playfair.

TESSELLARIA VOLVOCINA Playf.

See description and figures in "Freshwater Algae of the Lismore District" (These Proceedings, 1915, p. 315, Pl. xlv., f. 6, 7, under *Tessella*). Also a further note in "New and rare freshwater Algae" (*ibid.*, 1918, p. 508, Pl. lvi., f. 4). I have nothing to add to these notices except to remark that the organism is not as rare as I thought at first. I have obtained plenty during the last few years.

Fam. HYMENOMONADACEAE.

Genus Synura Ehrenberg.

SYNURA VIRESCENS (Bory). (Pl. ii., figs. 16—18).

Coenob. diam. ad. 137; cell. long. 22—24, lat. 7—9μ.

Wyrallah; Lismore (242, 314).

Syn. *Uvella virescens* Bory, Encyclop., 1824 (*teste* Dujardin, p. 301); for figure *see* Kent, Pl. xxii., f. 24—26, but the chromatophores are contracted. In "Freshwater Algae of the Lismore District," p. 314, I recorded this species as *Synura uvella* Ehr. All the authors, however, who have figured the latter, show the cells as clothed with fine setae; cf. Stein, T. xix., Abt. i., f. 1—7; Kent, Pl. xxiii., f. 1, 2; Senn, p. 162, f. 116A; Klebs, Flagellatenstudien (Senn's fig. A2) and others.

This makes it plain that if *S. uvella* is found here it must be very rare, as in twenty-five years I have never seen a specimen of a *Synura* showing setae. This smooth species, *S. virescens* Bory, however, is occasionally met with, though by no means common either. I figure three forms which may all be noted either separately or intermingled in the same coenobium. The membrane is very thin and does not show as a double line; the chromatophores lie close to it. No stigma noted, but I think that one or more minute stigmata may occasionally be found, though rarely, in all forms of *Synura* and *Mallomonas*. Stokes (*op. cit.*, p. 117) records this species from U.S.A.

For descriptions and figures of *S. granulosa* Playf. and its var. *pusilla* Playf. *see* Frw. Alg. Lismore District (These Proceedings, 1915, p. 314, Pl. xlv., f. 3). Also New and rare freshwater Algae (*Ibid.*, 1918, p. 508, Pl. lvi., f. 1—3).

For *Synura australiensis* Playf. *see* These Proceedings, 1915, p. 315, Pl. xlv., f. 4, 5.

Fam. OCHROMONADACEAE.

Genus OCHROMONAS Wysotski.

OCHROMONAS ASPERA, n.sp. (Pl. i., figs. 14, 15).

Cellulae a fronte subcirculatae anteriore saepe truncatae, posteriore rotundatae, margine granulis aspera; a latere modice compressae, ovatae, anteriore acuminatae; membrana nulla vel tenuissima et indistincta; plasmate granuloso, chromatophoris (2?) luteo-viridibus, obscuris; flagello singulo; vesiculis contractilibus geminatis minutis uno latere juxta marginem anteriorem dispositis; stigmate nullo.

Cell. diam. c. 8—10μ. Byron Bay (324).

A very minute flagellate composed of hyaline plasma studded with amylaceous granules which give a rough appearance to the surface, showing through the cell-wall if any is present as it is not noticeable. In shape the cell is sub-circular in front view, sometimes truncate above, and in side view somewhat compressed and ovate. There is an obscure patch of yellow-green chromatophore near the anterior end, a single flagellum and a pair of minute c.v. at one side near the front margin; no stigma. The animalcule can project outwards a large wave of membrane (?) or clear homogeneous plasma, and seize any particle of food in its vicinity.

OCHROMONAS CYLINDRACEA, n.sp. (Pl. i., fig. 16).

Cellulae cylindraceae, utroque polo rotundatae, in medio interdum paullo constrictae, margine granulis aspera; membrana nulla? vel tenuissima ?; plasmate granuloso; chromatophoris obscuris (2?) luteo-viridibus, juxta marginem anteriorem; flagello singulo; stigmate nullo.

Cell. long. c. 17, lat. 5μ. Byron Bay (324).

Cylindrical in shape, rounded each end, slightly constricted in the middle, other details as in the preceding species. Both forms obtained along with *Scintilla chlorina* from small rainwater pools in the drained bog at Byron Bay.

Genus DINOBRYON Ehrenberg.

DINOBRYON SERTULARIA Ehr. (Pl. i., figs. 17—21).

Cell. long. 26—38, lat. max. 9—10, lat. oris 8—10, constrict. 7—8μ. Cyst diam. 14μ.

Botany (2); Botanic Gardens (3); Sydney Water (22); Centennial Park, Sydney (133); Duck Creek, Clyde (74); Guildford (172); Fairfield (83, 143); Canley Vale (111); Wyrallah; Byron Bay; Lismore (332, 345, 307, 316).

Syn. *Dinobryon sertularia* var. *cylindricum* in Plankt. Sydney Water, p. 516, Pl. 57, fig. 6. Our common form answers exactly to Ehrenberg's type, but is apparently somewhat smaller. The usual size of the lorica here is long. 30—35, lat. max. 9, whereas for European specimens Lemmermann gives long. 44, lat. max. 13, lat. oris 13, constr. 10—11μ. Stein's figures work out at an average of long. 46, lat. max. 12μ.

I have met with none longer than 38μ, and Bernard, Protococc. et Desm., p. 209, f. 570, gives 28—35 by $8—10\mu$ for Javanese specimens.

Two shapes are found, (1) with blunt conical lower end, and (2) with the lower end drawn out and pointed; both are common and usually intermingled. The cyst which I have only noted twice is spherical with low broad collar, the membrane faintly and sparsely scrobiculate.

Var. ANGULATUM Seligo. (Pl. i., figs. 22—23).

Cell. long. 32—40, lat. 9, lat. oris 8—9, constrict. $7—8\mu$.

Fairfield (83, 112, 143).

Cf. Seligo, Uber einig. Flagell. d. Susswasser, p. 6, f. 1. *Syn. D. cylindricum* var. *angulatum* (Seligo) Lemm., Gatt. *Dinobryon*, p. 518, T. 18, f. 24. Lemmermann has arranged this form under *D. cylindricum;* I find it here, however, in company with *D. sertularia* and of similar dimensions. *D. cylindricum* is a much larger form than any of ours, so I think it best to fall back on Seligo's original arrangement. Probably the same form is common to both species.

DINOBRYON CYLINDRICUM var. DIVERGENS (Imhof) Lemm. (Pl. i., figs. 24, 25).

Cell. long. 42—50, lat. max. 8—10. lat. oris 8—10. constrict. $6—7\mu$.

Sydney Water (63, 64, 90); Centennial Park (133); Canley Vale (111); Fairfield (130).

Syn. *D. sertularia* var. *divergens* in Plankt. Sydney Water, p. 516, Pl. 57, f. 7. Nearly all the specimens I measured were either long. 44μ or long. 50μ.

Var. SCHAUINSLANDII Lemm.

Cell. long. 44—50, lat. max. $9—10\mu$.

Sydney Water (90); Canley Vale (111).

Syn. *D. sertularia* var. *Schauinslandii* in Plankt. Sydney Water, p. 516, Pl. 57, f. 8. Found in company with var. *divergens*, of which it is really only a form. Our specimens are so slightly wrinkled as to make separation difficult.

Subgenus EPIPYXIS (Ehr.) Lauterborn.

DINOBRYON UTRICULUS (Ehr.) Klebs. (Pl. i., figs. 26—27).

Cell. long. 20—25, lat. max. 7—8, lat. oris $4—5\mu$.

Sydney Water (22); Guildford (77).

Syn. *Epipyxis utriculus* Ehr., Infus., p. 123, T. viii., f. 7; Stein, T. xii., f. 6—11; Klebs, Zeitschr. f. Wiss Zool., Bd. 55, p. 414; Lemm., *l.c.*, p. 512, T. xviii., *f.* 1. Our specimens are much shorter than the European; Lemmermann gives long. 30—46, lat. $7—10\mu$.

Var. TABELLARIAE Lemmermann. (Pl. i., figs. 28, 29).

Lorica c. stip. 23—28, lat. max. 7—9, lat. orif. $4—5\mu$. Cyst. diam. 14μ.

Fairfield; Guildford (77, 124); Centennial Park, Sydney (133).

Lemmermann, Das Plankton schwedischer Gewasser, p. 119, T. i., f. 19. This pretty little form is not uncommon, growing on diatoms, waterweeds, etc. The cells are generally solitary or two together, rarely in clumps as in the figure. From the comparison of a number of individuals it is easy to see that the petiole is formed out of the cell wall by a gradual falling together of the lower end of the lorica. There seems to be a distinct disc to the footstalk, at least sometimes. The membrane differs from other species of *Dinobryon* in that it is

generally somewhat rufescent with a specially dark band across the middle. I have never seen the living animalcule. Lemmermann gives long. 22, lat. max. 8, opening 4—5μ as the dimensions of the lorica.

Cryptomonadineae.

Genus CHILOMONAS Ehrenberg.

CHILOMONAS PARAMECIUM Ehr. (Pl. ii., figs. 19—22).

Found in swamp waters almost everywhere; it seems to me very probable that it is a small saprophytic form of *Cryptomonas*; it has the same series of shapes as *Cryptomonas ovata.*

Cell long. c. 30, lat. c. 10μ.

Genus CRYPTOMONAS Ehrenberg.

CRYPTOMONAS OVATA Ehr. (Pl. ii., fig. 23).

Senn (Flagellata, p. 169) remarks on the variability of the chromatophores in this genus and it is particularly noticeable in this species. I have noted the following colours:—Pale nut-brown, deep nut-brown, brownish-green, greenish-brown, yellow-green, pale chlorophyll green, deep chlorophyll green. Almost always to be found in swamp waters, but never in great quantities.

Cell. long. 25—40, lat. 10—18μ.

CRYPTOMONAS AMPULLA, n.sp. (Pl. ii., fig. 24).

Cellulae quam in *C. ovata* majores, longe ovales, lateribus arcuatis; pone rotundatae, fronte oblique truncatae et infra, uno latere, valde excavatae. Chromatophoris fusco-viridibus.

Cell. long. 50, lat. 23, ap. 10½μ. Lismore (327, 337).

A larger form than *C. ovata* and more nearly oval in shape, rounded behind, sides arched, obliquely truncate in front. Below the lower edge of the truncate portion there is a deep excavation, making the cell appear somewhat irregularly flask-shaped. Chromatophores brownish-green, more green than brown, however. The interior seems to be differently arranged from *C. ovata* also, as there is a wide bag-shaped pharynx, longitudinally striate with rows of minute punctulations. Not common.

CRYPTOMONAS MAXIMA, n.sp. (Pl. ii., fig. 25).

Cellulae maxime, plus minus oblongae, fronte modice attenuatae, postice rotundatae; uno latere aequaliter arcuato, altero juxta apices interdum inflatione instructae; chromatophoris plerumque fusco-viridibus.

Cell. long. 50—70, lat. 22—28μ.

Botany (142); Lismore (261, 327, 337).

Double the size of *C. ovata* and much more irregular in shape. It is oblong in general outline, somewhat narrowed back and front, especially the latter. One side is fairly regularly arched, but the other has often a slight protuberance near each end. The chromatophores are generally brownish-green, but I have noted them pale-green and yellow-green.

CRYPTOMONAS NORDSTEDTII (Hausgirg) Senn. (Pl. ii., fig. 26).

Cell. long. 11—12, lat. 6—7μ. Sydney; Lismore (345, 347).

Syn. *Croomonas Nordstedtii* Hausgirg, whose figure is reproduced by Senn,

p. 169, fig. 123c; the size works out at 9 × 5μ. A minute form not uncommon here, but never before more than a few individuals at a time. The chromatophores are described as blue-green and I have once noted them that tint, but strong and often bright blue is the rule, and turquoise-blue may sometimes be observed. Occasionally what resembles a small pyrenoid is present near the centre of the cell, or two smaller, one above the other.

CRYPTOMONAS GEMMA, n.sp. (Pl. ii., fig. 27).

Cellulae ad *C. ovatam* ambitu valde accedentes, ellipticae, sursum uno latere oblique truncatae; hyalinae pellucidae in medio chromatophoris binis globosis cyaneis instructae.

Cell. long. circa 20μ. Lismore (291).

This is a very curious form which I have met with only once, but it was present in much greater abundance than *Cryptomonas* generally is, four or five being in the field of view at one time. In shape like *C. ovata*, it is perfectly hyaline and pellucid, no internal markings at all being visible except the two chromatophores which were bunched up together in the centre of the cell in the form of two, sharply-defined, bright blue globules. All the specimens were alike. In movement they were very lively; flagellates with blue chromatophores generally are.

CRYPTOMONAS OBLONGA, n.sp. (Pl. ii., fig. 28).

Cellulae minutae oblongae, utroque polo rotundatae, sursum haud truncatae; lateribus parallelis subrectis; chromatophoris dilute aeruginosis 2; stigmate nullo; c.v. subapicali.

Long. 11, lat. 6μ. Lismore.

A minute oblong form with rounded ends, not truncate in front, sides more or less straight. There were two pale blue-green chromatophores and a subapical c.v. but no stigma. A little below the centre what looked like a pyrenoid or elaeoplast. I saw only one flagellum but probably there were two, as the pyrenoid and the colour of the chromatophores indicate *Cryptomonas* and not *Mallomonas*. Non-motile at first, the cell became motile while under observation.

Eugleninae.

Fam. EUGLENACEAE.

Genus EUTREPTIA Perty.

EUTREPTIA VIRIDIS Perty. (Pl. iii., fig. 1).

This is a rare flagellate; I have only met with it in one gathering, where, however, it occurred in good numbers. I am not quite certain whether ours is the same as the European form. It is like *Phacus moniliata* var. *suecica* Lemm. with the body slightly elongated and produced below into a long blunt tail. Daugeard, who figures it (Recherches sur les Eugleniens, p. 103, fig. 24) makes no mention of any granules, whereas our specimens are finely puncto-granulate in spiral lines running obliquely and transversely from left to right. In side view it is elliptic, compressed. Differs from *Phacus* in having no amylaceous plates.

Cell. long. max. 58, caud. 21, lat. corp. 25, apic. 10μ. Botany (95).

Genus CRYPTOGLENA Ehrenberg.

CRYPTOGLENA AUSTRALIS, n.sp. (Pl. v., fig. 18).

Cellulae late-ovatae, posteriore latiores, paene subglobosae, postice vix acuminatae, fronte quam levissime deplanatae. A latere ellipticae.

Cell. long. 13, lat. 10μ. Lismore.

Cryptoglena pigra Ehr., the only species hitherto described, is shield-shaped, triangular, broadest above and very pointed below. Cf. Daugeard, *op. cit.*, p. 139, f. 44; Senn, p. 176, fig. 127B. Our form is very broadly ovate, almost subglobose, widest below, hardly pointed beneath and very slightly flattened above. The usual deep furrow runs down one face. In side view elliptic, slightly pointed below and flattened above. One long flagellum; stigma to one side of the furrow; chloroplasts laminar, a brilliant green. Very rare.

CRYPTOGLENA PHACOIDEA, n.sp. (Pl. v., fig. 19).

Cellulae orbiculares, inferne modice angustatae, utroque polo ob sulci extremitates emarginatae; a latere plano-convexae lenticulares.

Cell. long. 21, lat. 17μ. Lismore (351).

Another very rare form which seems to connect *Cryptoglena* with *Phacus*, for it shows two amylaceous plates, one large and the other small. The general shape in face view is subcircular, a little narrowed below. There is a broad furrow down the centre, the ends of which show as an emargination at each pole. The stigma lies to the left of the furrow as usual and there is the customary single long flagellum. In side view the cell seems to be lenticular, plano-convex, showing gibbous where the furrow runs. I have an idea that this is a juvenile form of *Phacus*, the furrow being eliminated with growth, the last vestiges of it persisting as the overlap of the two wings above, and the slight tail below; also the central longitudinal ridge in *Phacus triqueter*. *Cf.* too *Phacus inflatus* (*infra*).

Genus COLACIUM Stein.

COLACIUM VESICULOSUM (Ehr.) Stein. (Pl. iii., figs. 2, 3).

Cell. veg. long. 9—15, lat. 5—11μ. Motile zooid not noted.

Lismore (291, 307). On *Cyclops, Macrothrix* (*Entomostraca*).

COLACIUM ELONGATUM, n.sp. (Pl. iii., figs. 4—6).

Cellulae vegetativae cylindraceae, fronte conicae, postice rotundatae, apicibus stipite mucosa affixae. Zoosporae angustae cylindraceae, medio modice constrictae, apicibus attenuatis acuminatis; stigmate lineari luteo-fusco subapicali; vesiculis contractilibus 2 subapicalibus; flagello singulo, chloroplastidibus dilute viridibus ellipticis.

Cell. veg. long. 12—23; lat. 5—11μ. Zoosp. long. 15—18, lat. 4μ.

Lismore (291, 294, 316, 327).

The vegetative form of *C. vesiculosum* is shortly ovate, that of *C. elongatum* is more or less cylindrical, rounded behind and conical in front where it is fixed to the host by a short stalk of almost invisible mucus. The host is nearly always *Cyclops, Macrothrix* or some other of the Entomostraca. From 2 to 4 cells are often found in a clump. What seem to be the zooids of this species are cylindrical, constricted in the middle, attenuate, and pointed at each

end; chloroplasts pale green, irregularly oval, disposed more towards the hinder end; flagellum single; c.v. two, apical; and a yellow-brown, wick-shaped, sub-apical stigma. A stigma of this shape and colour is extremely rare among the *Euglenineae*, though not uncommon in *Chlamydomonas* of the *Volvocaceae*.

Genus EUGLENA Ehrenberg.

EUGLENA VIRIDIS Ehr. (Pl. iii., fig. 7).

Of medium size; when young fusiform in shape (cf. fig. 9), but with growth tending to become cylindrical; blunt in front and rapidly attenuated behind where it is drawn out into a minute tail. No flagellum, or only the useless stump of one. Amylaceous granules irregular in shape and size, generally forming a large central mass in front of and behind the nucleus. Membrane smooth but very fine spiral striae can generally be detected with a high power lens on all species of *Euglena*. A few minute digitate chloroplasts are usually visible in the hinder part of the cell, but the usual discoid chloroplasts form with age, principally in the central portion, leaving the ends hyaline. From Daugeard's description and figure (Recherches sur les Eugleniens, p. 43, fig. 1A, D) the young fusiform specimens are characterised by a stellate bundle of digitate chloroplasts radiating from the centre of the cell. The dimensions he assigns are long. 68—80, lat. 14—16μ. This is perhaps more nearly Ehrenberg's type. That which I figure here is the older cylindrical form: long. c. 110, lat. 14μ.

This species develops in the globular vegetative cell in a manner peculiar to itself. Both head and tail are turned in under the body, on the same side, to form a ball. When the mucus in which this globular cell is involved gets sufficiently thin for the creature to get free, it simply unrolls head and tail and straightens itself out.

Var. SANGUINEA (Ehr.).

Euglena sanguinea Ehr. This red form is usually found in company with the type, especially when, as often happens, the organisms form a powdery crust on the surface or on the half-dry bed of a pool. It is probably due to the action of sun and air. Under the microscope the colour will be seen to be due to the gradual conversion of the chloroplasts into orange or brick-red globules of haematochrome (lipochrome). This is known to take place in the *Protococcaceae* also.

Var. PURPUREA, n.var.

A rarer and very striking form. The chlorophyll has become converted into a wine coloured substance disposed to all appearances in fine grains.

EUGLENA SOCIABILIS Daugeard. (Pl. iii., figs. 8, 9).

Very like the young form of *Euglena viridis*, but broader and more clavate in front. It may always be recognised by the digitate chloroplasts regularly disposed from front to back. Amylaceous granules irregular in shape, arranged in a mass before and behind the nucleus and below the chloroplasts. Membrane smooth, finely striate spirally and obliquely from left to right. With or without a flagellum.

Long. 92—95, lat. 21—28μ. Lismore (254, 293, 308, 316, 327).

Cf. Daugeard, *op. cit.*, p. 86, fig. 15; for dimensions he gives 85 × 25μ. This species almost certainly develops into the cylindrical form of *Euglena viridis* mentioned above. It is really the young *aquatic* form, while *E. viridis*

type is the *aerial* form, when the organism develops in surface crusts. ***Euglena sociabilis*** living and growing altogether under water has a characteristic method of development and a series of vegetative stages entirely its own. Yet without a doubt it reaches the same objective.

The vegetative cell is generally involved in a wide and often stratified globe of clear mucus.

EUGLENA AMBLYOPHIS (Ehr.) mihi. (Pl. iii., figs. 10, 11).

Syn. *Amblyophis viridis* Ehr. It has generally been considered that there is nothing in this form to justify Ehrenberg's genus *Amblyophis;* at the same time I cannot agree with those who would make it merely a tail-less form of *Euglena viridis.* For one thing, the disposition of the cell-contents is different. Also the latter is a comparatively small species (the type at any rate), whereas *Euglena amblyophis* is one of the very largest forms. It is strap-shaped, rounded behind and attenuated in front, membrane smooth, finely and spirally striate, body very transparent, no paramylon granules or rods (in this respect also very different from *E. viridis*), no flagellum. Specimens from three localities fairly wide apart are all in agreement.

Long. 200—300, lat. 20—25μ.

Botanic Gardens, Sydney (137); Kyogle (216); Lismore (286).

EUGLENA DESES Ehrenberg. (Pl. iii., figs. 12—14).

This species is narrowly strap-shaped and very plastic, slightly attenuate in front and usually coming abruptly to a sharp point behind, but sometimes very gradually narrowed to a subacute tip; no tail and only a very weak flagellum or none at all. Membrane smooth, striae not noted. In most *Euglenae* the striae are very delicate and need the 1-12th inch homog. immersion lens for their detection. The same is true of the chloroplasts except in certain species of which this is one. Here, on the other hand, they are nearly always very distinct, especially at the sides where they show as little lenticular cushions, and are characteristic of the species. No paramylon granules or rods as a rule.

Long. 100—180, lat. 10—18μ.

Coraki; Wyrallah; Lismore (237, 254, 258, 293, 295, 347).

In a mucous stratum of *Spirulina major* gathered on the river-bank at Coraki, there were numbers of *E. deses* developing out of the vegetative cell, from which (Pl. iii., fig. 14) it was evident that they are formed by direct growth out of the original cell itself.

Var. MINUTA, n.var. (Pl. iii., fig. 15).

Dimensionibus quam in forma typica dimidio minoribus; long. 70, lat. 6μ. Lismore.

Var. GRACILIS, n.var.

Forma gracilior, chloroplastidibus haud distinctis; long. 120, lat. 8μ. Casino.

It seems probable that *E. deses* is the base form from which both *Euglena spirogyra* and *E. acus* are developed. Along with this narrow form was another of similar size and shape, but exhibiting the granulate striae of *E. spirogyra* and at the same time the acutely pointed tail of *E. acus*. Upon another occasion I noted a form with the shape and conspicuous chloroplasts of *E. deses*, but with the series of paramylon rods characteristic of *E. acus*, and with a tail end evidently a compromise between the two species. *Cf.* Daugeard, *op. cit.*, p. 93,

fig. 18, var. *intermedia*, Klebs and p. 94 where he says: "cette variété est caractérisée par la présence au-dessus et au-dessous du noyau de quelques longs bâtonnets de paramylon assez gros." (Pl. iii., fig. 16).

EUGLENA OXYURIS Schmarda. (Pl. iii., fig. 17).

One of the largest species. It is a strap-shaped form, sometimes slightly twisted round the long axis. The spirals and striae (the latter are coarser and more conspicuous than usual) run from *right to left* obliquely downwards, focussing the upper surface. This is unusual, not to say unique, in the genus. From two to four stout paramylon rods in a single series; no flagellum; a short stout spine behind. The chloroplasts are brick-shaped (4μ long) following the lines of the striae. Stigma very large, pale, and indistinctly outlined.

Long. 250—400, lat. 22—46μ. Coogee (4); Botany (91).

Cf. Dangeard, *l.c.*, p. 100, fig. 20, who gives long. 490, lat. 30—40μ. also Stein, T. xx., f. 4, 5 (not f. 6, which is *E. tripteris* Duj.).

A smaller form may also be met with:—long. 156—250, lat. 20—22μ.

Var. HELICOIDEA (Bernard) mihi. (Pl. iii., fig. 18).

So strongly twisted as to show three nearly equal lobes, in other details like the type.

Syn. *Phacus helicoideus* Bernard, Protococc. et Desm., p. 206, Pl. xvi., f. 563.

Long. c. spin. 360—400, lat. 40—60, spin. long. c. 40μ. Guildford; Kyogle (219); Lismore (237, 260, 271).

Var. GRACILLIMA, n.var. (Pl. iii., fig. 19).

Forma gracilior, minime torta. Long. c. spin. 253, lat. 17, spin. long. 42μ. Lismore.

A very rare slender form. Hardly twisted at all and, curiously enough, in reverse direction to the type, though the striae run the usual way. The paramylon rods in this species are really flattened links, in which the central space has become filled up by gradual thickening of the sides. Its position is still indicated by a faint central line.

EUGLENA TRIPTERIS (Duj.) Klebs. (Pl. iv., fig. 1).

In spite of its great likeness to *Euglena oxyuris* v. *helicoidea*, this is a very distinct form, very much smaller, more common, and one that retains its characteristics remarkably well. It generally has a long flagellum. The only note I have of the twist is that it is from left to right, the opposite of *E. oxyuris*. Compare Dujardin, p. 338, Pl. v., f. 7, whose figure the generally accepted form does not very closely resemble; he gives long. 65—80μ; also Stein, T. xx., f. 6, who considers it a young form of *E. oxyuris*.

Syn. *E. torta* Stokes, *l.c.*, p. 86, Pl. i., f. 20.

Long. 70—150, lat. 10—15μ. Wyrallah; Lismore (237, 254, 258, 286, 293, 310).

EUGLENA SPIROGYRA Ehr. (Pl. iv., fig. 2).

Easily recognized by the characteristic granulate striae which, in this species, are very much in evidence and, as a rule, run obliquely from left to right. The typical form (*cf.* Stein, T. xx., f. 7) seems to be cylindrical, slightly attenuate in front, but rapidly narrowing behind into the short acute tail. Membrane somewhat rufescent giving the specimens a yellow-green colour.

Another form, however, which I have found in great quantity, is broadly strap-shaped, not at all, or very slightly, attenuate in front where it is broadly truncate; behind narrowing rapidly to the short acute tail. The membrane in this form is generally very rufescent, the specimens appearing greeny-brown. I have no figure of this form, though it is very common. On decomposition the skin often splits up into a wisp of longitudinal fibres, the striae, which are then seen to be composed entirely of the granules, showing as minute brick-shaped cylinders set on end side by side.

Long. 160—250, lat. 18—36, long. caud. 25—30μ. Sydney; Wyrallah; Lismore.

Forma. (Pl. iv., fig. 3).

Cylindrical, rounded in front, and attenuate behind into a short tail. An interesting form showing beyond a doubt that the membrane may be at first smooth, the granules developing by degrees. Specimens indeed are often noted in which every second or fourth row of granules is more strongly marked, the intermediate series being of later growth. Paramylon rods link-shaped in this species as in *E. oxyuris*.

Var. ELEGANS, n.var. (Pl. iv., fig. 4).

Forma anguste cylindracea, fronte minime attenuata, postice in caudam brevem acutam producta. Membrana hyalina tenuissima, striis delicatissimis, minute granulatis. Flagello nullo.

Long. 110—136, lat. 8—12, long. caud. 10—16μ. Casino (223); Lismore (293).

A small and very slender cylindrical form, almost truncate in front and rapidly narrowed behind. The membrane clear, delicate and very finely striate with minute puncta-granules. No flagellum and no paramylon rods. On others in the same gathering no granules at all could be detected. Out of mud from the edge of a lagoon.

EUGLENA ACUS Ehr. (Pl. iv., fig. 5).

Fusiform, subrostrate in front, very gradually attenuate behind, where the lines of the body merge uninterruptedly into the long, acutely pointed tail. Generally active, with a long flagellum. Membrane very smooth, no striae visible. A long series of 6—10 paramylon rods is characteristic, though not always present.

Long. 150—210, lat. 10—12½μ. Auburn; Lismore (258, 327).

Cf. Stein, *op. cit.*, T. xx., f. 10—12; Daugeard, *l.c.*, p. 101, f. 22. I doubt whether I have ever seen a typical specimen of this species (as distinct from *E. acutissima* Lemm.). The figures cited are more distinctly fusiform than anything I have met with. Stein's specimens have the appearance of being distorted, and the rostrate tip does not seem correct. Daugeard's figure is better in this respect, but the tail is not nearly long enough to represent our forms. The only difference between this and the succeeding species is the slightly greater breadth and the wealth of paramylon rods. The chloroplasts are often little oblong cushions.

EUGLENA ACUTISSIMA Lemmermann. (Pl. iv., fig. 6).

Lemmermann, Plankt. Schwed. Gewass., p. 122, T. i., f. 27, who gives long. 123, lat. 7, flag. long. 25μ. This is really a slender, more cylindrical form of

E. acus, and is the form commonly found in our waters. I include in it specimens over 100μ long. and up to 8μ in diameter.

Long. 110—150, lat. 7—8μ. Guildford (45, 146); Lismore (237, 241, 258, 259, 260, 295).

Var. PARVA, n.var. (Pl. iv., figs. 7, 8).

Forma brevior. Long. 54—94, lat. 6—8, long. caud. 4—16μ. Lismore (237, 258).

A short form, less than 100μ long, sometimes blunt ended behind.

Var. HYALINA, n.var.

Forma hyalina, chloroplastidibus nullis, nec stigmate.

Long. 150—200, lat. 8—10μ. Rookwood; Guildford; Wyrallah; Lismore.

Euglena acus has also a var. *hyalina* Klebs..

EUGLENA PISCIFORMIS Klebs. (Pl. iv., figs. 9—11).

A small form, but one of the most active and frequently met with. In shape it varies somewhat, but generally it is shortly fusiform, with the likeness to a fish from which it derives its name, subrostrate in front and acutely pointed behind, without a tail. No amylaceous rods or granules. The specimen shown in Pl. iv., f. 11 is more globose in the centre than usual. It has probably just developed out of the globular vegetative cell, the shape of which it still partly retains. The long flagellum enables this form to swim very rapidly. Compare Klebs, Flagellatenstudien, p. 302; Daugeard, *l.c.*, p. 89, f. 16A; the latter gives dimensions long. 30, lat. 6—7μ. It is doubtful, however, if his figure represents the type.

Long. 30—32; lat. 6—12μ. Casino (223); Lismore (221, 237, 258, 260, 263, 295, 327, 344, 348).

EUGLENA TEXTA (Dujardin) Senn. (Pl. iv., fig. 12).

Syn. *Crumenula texta* Dujardin, p. 339, Pl. v., f. 8; *Euglena viridis, pro parte*, Stein, T. xx., f. 26—33; *Trachelomonas torta* Kellicott, in Stokes, Infusoria of U.S., p. 87, Pl. i., f. 24.

The type is oval, somewhat attenuate in front. This species seems to me to be merely the vegetative cell which has increased in size and become motile with hardly any alteration in shape. It has nothing to do with *Lepocinclis ovum;* and *Trachelomonas torta* Kellicott is simply the empty membrane, with the striae of both upper and lower face put in at the same time. This is a plankton form, generally to be found among weeds in deep water. The chloroplasts are disc-shaped, irregularly circular or polygonal, and close together; they are much more distinct than in any other species. Membrane smooth and covered with the usual fine spiral striae, with difficulty visible except on the empty cell. Cytoplasm granular; a large stigma and long flagellum, movement active. Dujardin gives long. 50μ.

Long. 50, lat. 40μ. Lismore (352).

Var. OVATA, n.var. (Pl. iv., fig. 13).

Forma ovata, fronte attenuata, pone rotundata; ceteris ut in forma typica.

Long. 38—50, lat. 25—32μ. Duck Creek, Clyde; Lismore (261, 337, 347, 348).

The most common form here; distinctly ovate, not oval.

Var. OBESA, n.var. (Pl. iv., fig. 14).

Forma fere sphaerica, superne quam levissime producta.

Long. 55, lat. 52μ. Lismore.

A rare form, almost exactly spherical, but produced a little above and notched at the opening of the pharynx.

Var. BULLATA, n.var. (Pl. iv., figs. 15, 16).

Forma subglobosa, sursum in protuberationem conicam producta, pone bullâ latissimâ instructa.

Long. 53—55, lat. 42—46μ. Lismore (328).

This form is globose but more produced above into a distinct conical protuberance, while below it is furnished with a low wide boss.

EUGLENA GUTTULA, n.sp. (Pl. iv., fig. 17).

Euglena minima, fere sphaerica; fronte bulla conica instructa; pone rotundata, interdum quam levissime acuminata; flagello longo; cytoplasmate interdum granulato.

Long. 18—19, lat. 14—17, lat. ap. 2—3μ. Guildford (146); Lismore.

Another free-swimming species, found among weeds in deep water, smaller and rarer than ***Euglena texta*** and its forms. It is globular, with a conical projection in front. The chloroplast seems to be in a single, thin, parietal, equatorial band; flagellum long, movements lively.

Var. ELONGATA, n.var. (Pl. iv., fig. 18).

Forma modice oblongo-cylindracea, medio paullo constricta, sursum leviter attenuata, fronte rotundata acuminata, postice globosa. Cytoplasmate hyalino; in medio zona chlorophyllacea; flagello longo; vesiculo contractili subapicali; pone macula fusca magna (stigmate?) instructa.

Long. c. 19—22, lat. c. 10μ.

Seems to be an outgrowth of the type. In shape oblong-cylindrical, somewhat constricted in the middle, narrowed in front and conical, running to a point, globose behind. A subapical c.v. noted, and, in the centre of the posterior half of the cell, a large pale-brown spot or globule which might be a stigma, though I have never before seen the stigma in such a position in ***Euglena***. As in the type, there is a thin median parietal band of chlorophyll. Flagellum long, movements very active.

EUGLENA VIVIDA, n.sp. (Pl. iv., fig. 19).

Euglena minima, lineari-elliptica, fronte acute-rotundata, postice rapide attenuata et acuminata; cauda nulla; chloroplastidibus parietalibus singulis, utrinque pyrenoidibus magnis singulis; stigmate parvo; flagello longo; granulis amylaceis nullis nec baculis.

Long. 30—32, lat. 7μ. Lismore (293, 347).

A minute but most energetic species, swimming rapidly, turning and twisting at a great rate. ***Euglena vivida*** is very distinct and clear-cut in appearance, linear elliptic, acutely rounded in front and rapidly narrowed behind into a sharp point, but without a tail; very much more resembling a fish than ***Euglena pisciformis***. There is a single parietal laminar chloroplast (or two), with a large distinct pyrenoid on each side at the posterior third. Stigma small; flagellum long; no paramylum rods or granules. Not common, but I have known gatherings where it was plentiful.

EUGLENA PUSILLA, n.sp. (Pl. iv., figs. 20, 21).

Euglena minima, cylindracea, utroque fine attenuata, fronte conica, postice abrupte acuminata, caudâ minimâ instructa; baculis amylaceis singulis maximis.

Long. corp. 26—30, lat. 9—10; long. caud. 3—4μ. Lismore (260).

Another minute species, in shape something like *E. vivida,* but very different in details. The body is cylindrical, narrowed at each end, conical in front and abruptly acuminate behind, where there is a short tail. The chloroplasts seem to be scattered flakes, sometimes connected with an irregular paramylum granule; a single, very large and stout paramylum rod in the centre; flagellum?

Var. LONGA, n.var. (Pl. iv., fig. 22).

Forma pisciformis, uno latere fere recto, altero arcuato, fronte attenuata, pone spinâ praedita, baculis amylaceis binis validis.

Long. c. sp. 74, lat. 16; sp. long. 12μ. Lismore (237, 238).

Another very fish-like form, longer than the type, attenuate in front, furnished with a spine behind, one side nearly straight, the other arched. Two stout paramylum rods present. This variation was plentiful in gathering 238; both it and the type have stout membranes and are not metabolic.

? EUGLENA sp. (Pl. iv., fig. 23).

I have seen but one specimen of the form here figured, but, although I was able to observe all details, I regard it with too much suspicion to name or describe. It is a minute form with a long flagellum, and very vivacious in its movements, as these small forms generally are. Several indications point to the possibility of its being the zooid of *Trachelomonas* escaped from a broken lorica. This is not impossible, but I have no knowledge as to whether *Trachelomonas* will remain active under these conditions. The size and shape are exactly those of *Tr. ampullula* Playf. ("The genus Trachelomonas," p. 16, Pl. ii., f. 6); unfortunately, I have no note on the constitution of its zooid. The huge, square, pale stigma, however, is more general in *Trachelomonas;* the subglobose nucleus *at the hinder end* of the cell I have never observed in *Euglena* before, and it usually points to a loricate animalcule (compare the Rhizopoda); the chlorophyll diffused through the outer layer of cytoplasm is frequent in *Trachelomonas,* but rarely, if ever, found in *Euglena.* Compare *Tr. splendida,* Pl. vii., f. 1.

Genus P H A C U S Nitzsch.

PHACUS PLEURONECTES (Muller) Duj. (Pl. v., fig. 1).

Long. corp. 36—56, lat. 27—42; long. caud. 7—14μ.

Auburn (68); Rookwood; Botany (91); Guildford (45, 77); Casino; Wyrallah; Lismore (187, 258, 260, 295).

Dujardin, *op. cit.,* p. 336, Pl. v., f. 5, gives for dimensions, long. 40—45, lat. 22½—30μ, which is a fair average size.

Var. MINUTUS, n.var. (Pl. v., fig. 2).

Quam forma typica dimidio minor. Long. 20—28, lat. 11—22μ.

Botanic Gardens, Sydney (3); Wyrallah; Lismore (260).

Half as large only as the type and much less common.

Var. AUSTRALIS, n.var. (Pl. v., fig. 3).

Forma magis ovalis, duplo major. Long. 90, lat. 53μ. Guildford (114).

Very rare indeed; more regularly oval than the type and about twice the size. In all these forms the chloroplasts are minute parietal discs scattered over the central part of the cell.

PHACUS HISPIDULUS (Eichwald). (Pl. v., fig. 4).

Long. corp. 30, lat. 22; long. caud. 10μ. Lismore (328, 332).

Syn. *Euglena hispidula* Eichwald; *Chloropeltis hispidula* Stein, T. xix., f. 41—44.

Very rare here. It is without the overlap at the apex, but instead is furnished with a small papilla. The membrane is ornate with small teeth, pointing backwards, disposed in longitudinal lines. The tail is straight.

PHACUS MONILATA var. SUECICA Lemmermann. (Pl. v., fig. 5).

Long. corp. 30—34, lat. 23—24, crass. 6; long. caud. 7—8μ.

Casino; Wyrallah; Lismore (241, 258, 350, 351).

Cf. Chloropeltis monilata Stokes, p. 91, Pl. i., f. 30. This species is really a variant of *Phacus hispidulus*, the teeth being replaced by granules as in many forms of *Trachelomonas*. I have not met with the type which is figured by Stokes with granules irregularly disposed. Not uncommon here. Compare Lemmermann (Plankt. Schwed. Gewass, T. i., f. 15) who gives size as 36 × 22½μ.

PHACUS LONGICAUDA (Ehr.) Dujardin. (Pl. v., fig. 6).

Long. corp. 53—90, lat. 40—65; long. caud. 67—90μ.

Botanic Gardens, Sydney (150); Guildford (45); Lismore (258, 295, 347, 350).

Euglena longicauda Ehr. Our specimens have sometimes very long tails. Dujardin only gives 92μ *with the tail.* This is the typical, flat form.

Var. ——— Lemmermann. (Pl. v., fig. 7).

Long. corp. 62—80, lat. 40—54; long. caud. 20—40μ.

Botanic Gardens, Sydney; Wyrallah; Lismore (258, 260, 347).

Syn. *Ph. pleuronectes, pro parte,* in Bernard, Protococc. et Desm., Pl. xvi., f. 561 only. This twisted variety has a much shorter tail than the type. Lemmermann has given it a name, but I cannot lay my hand on the reference.

PHACUS TRIQUETER (Ehr.) Dujardin. (Pl. v., figs. 8—11).

Long. 38—44, lat. 25—32μ. Lismore (348, 350, 351).

Dujardin, *l.c.*, p. 338; Stein, T. xix., f. 55—57. Compare *Cyclanura orbiculata* Stokes, p. 89, Pl. i., f. 27; and *Phacus acuminatus* Stokes, p. 90, Pl. i., f. 28. Rather rare, it may be recognised by the ridge running longitudinally down one face.

PHACUS INFLATUS, n.sp. (Pl. v., figs., 12, 13).

Phacus minimus, ad *Ph. pleuronectem* accedens, quasi autem e lobis inaequalibus binis tumidis exstructis; uno lobo per longitudinem, altero transverse inflato; lobo longiore cauda brevi praedito.

Long. corp. 25—32, lat. 22—23; long. caud. 4—6μ. Lismore (236, 237, 295).

A very small form something after the style of *Phacus pleuronectes*, but as if constructed of two inflated lobes joined down the central line. The lobes are unequal in size and shape, one being longitudinally inflated, the other trans-

versely. A short tail on the longer lobe. Membrane longitudinally striate, a large paramylum plate present, stigma distinct, flagellum long. Very rare, but numerous in certain gatherings.

PHACUS LISMORENSIS, n.sp. (Pl. v., fig. 14).

Phacus magnus, longe-ovatus, uno latere paullo infra apicem levissime excavatus (deinde pharynge oriente ac flagello longo); sursum subacute rotundatus, inferne sensim sensimque attenuatus et in caudam longam acutissimam, oblique dispositam, protractus; membrana per longitudinem striata. A latere, corpore lineari, arcuato; lateribus parallelis; postice caudâ longâ, ad angulo recto deflecta.

Long. corp. 54, lat. 18; long. caud. 40μ. Lismore (260, 344, 348).

A very distinct, well-marked species, known only from Lismore. The body is flat like a leaf, not lenticular; long ovate, rounded above, and gradually narrowed below into a very long sharp-pointed tail set obliquely (in front view). The opening of the pharynx is situated in a little indentation on one side at some distance below the apex. From here also, of course, arises the long flagellum. Membrane longitudinally striate; the chloroplasts small, oblong flakes lying along the striae. From the side, the body is seen to be somewhat arched, the sides parallel and close together, the tail set at right angles.

PHACUS PYRUM (Ehr.) Stein.

Euglena pyrum Ehr. I have never come across the exact European type as figured by Stein, T. xix., f. 51—54, and other authors; but the following forms of it are found here and always retain their distinctive characteristics.

Var. OVATUS, n.var. (Pl. v., fig. 15).

Forma corpore ovato fere ovali, sursum late-rotundata, inferne attenuata, cauda brevi acutissima hyalina praedita.

Long. corp. 19, lat. 13; long. caud. 6μ. Botany (142); Lismore.

The type is somewhat narrowed above and excavated apparently below the apex on one side. Our nearest form is quite rounded above, in shape like a peg-top, slightly attenuated below, where it is furnished with a short hyaline sharp-pointed tail. There are 6 or 7 coarse spiral costae running from left to right.

Var. AUSTRALICUS mihi. (Pl. v., fig. 16).

Forma ad v. *ovatum* accedens sed crassior, et costis pluribus ornata.

Long. corp. 22—32, lat. 18—24, long. caud. 8—10μ. Lismore (197, 242).

Syn. *Lepocinclis Steinii* v. *australica* Playf., Biol. Richmond River, p. 141, Pl. viii., f. 6. A more inflated form of the foregoing, and with more numerous costae which are rounded also, not sharp-edged. End view circular in both forms.

Var. RUDICULA, n.var. (Pl. v., fig. 17).

Forma corpore conico sursum truncato-rotundata, inferne attenuata, lateribus arcuatis; postice cauda brevi praedita. A latere valde compressa, lateribus parallelis. Membrana costis rotundatis 4—7 ornata.

Long. corp. 24—35, lat. 15—26, long. caud. 14—18μ.

Lismore (241, 258, 260, 285, 286).

The type and preceding forms are circular in cross section; this form, on the other hand, is strongly compressed. In shape conical, truncately rounded

above, narrowed gradually beneath, and furnished with a short sharp tail. Membrane with 4—7 spiral corrugations wound from left to right.

Genus LEPOCINCLIS Perty.

LEPOCINCLIS OVUM (Ehr.) Lemm. (Text-fig. 3*a*).

Long. 23—30, lat. 17—21, long. caud. 2—10μ.

Guildford; Lismore (242, 299).

Syn. *Euglena ovum* Ehr., *Chloropeltis ovum* Stein. This species is rather rare here, I have only met with a few isolated specimens. In shape the type, according to Stein (T. xix., figs. 45, 46, 49, 50), is broadly oval-oblong with an anterior prominence and a short, pointed, triangular tail, membrane finely striate spirally. Forms found here are not infrequently more oblong than oval, and often lack the anterior prominence, sometimes the tail as well. I might remark that these are *generic* characteristics in *Lepocinclis;* it is no use founding species on their presence or absence.

Var. AUSTRALIS, n.var. (Text-fig. 3 *b, c*).

Forma oblonga, ubique rotundata, anteriore haud producta, postice caudâ obtusa brevi papilliformi, vel longa bacilliformi, instructa. Membrana delicatissime spiraliter striata.

Long. 23—30, lat. 17—21, long. caud. 2—11μ.

Guildford (146); Lismore (328).

A decidedly oblong form, rounded on all sides, with no anterior prominence in the specimens so far noted, furnished behind with a short nipple-shaped tail, or more rarely a long, blunt-ended, rod-like one. Membrane finely striate spirally.

Var. COSTATA, n.var. (Text-fig. 3*d*).

Forma oblonga, ubique rotundata, prominentiâ anteriori nulla nec cauda. Membrana costis spiralibus 9—10 ornata.

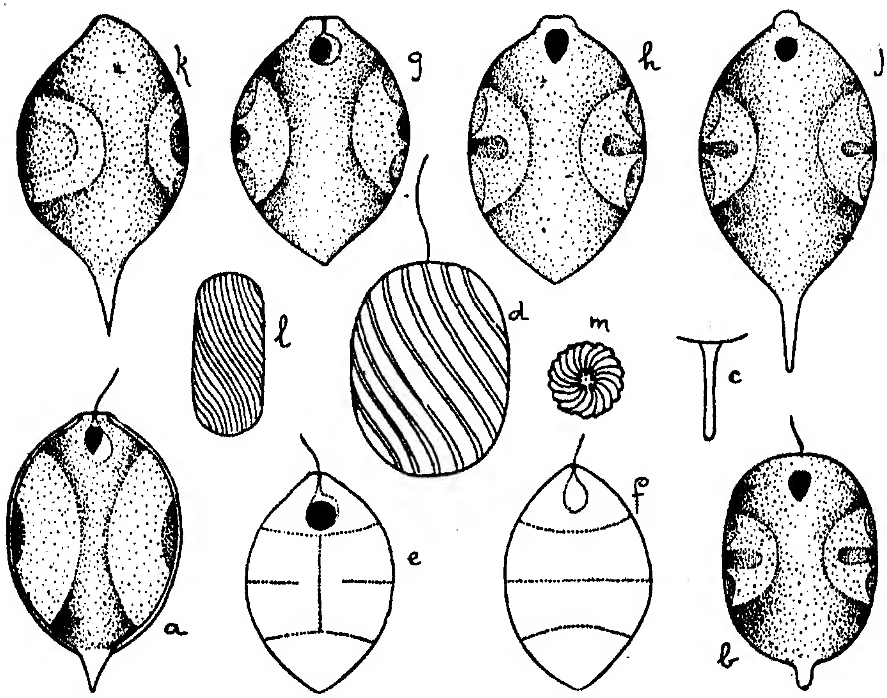
Long. 24, lat. 18μ. Guildford (60).

The oblong form, without either anterior prominence or tail, though of course these might be present, either one or both, in other specimens, membrane with 9—10 costae spirally wound.

LEPOCINCLIS FUSIFORMIS (Carter) Lemm. (Text-fig. 3*e*—*h*).

Syn. *Euglena fusiformis* Carter; *Euglena zonalis* Carter, according to Kent, Pl. xx., f. 58 (after Carter). The name is somewhat misleading, as one expects a spindle-shaped cell to be much longer in proportion to its width than this is. The type is broadly lenticular, pointed above and below, apparently without anterior prominence or caudal prolongation of any sort, half as long again as broad in our specimens, but these are not always typical. The figure of *Euglena zonalis* given by Kent works out at 58 × 30μ; it is probably just a slightly more slender form than is typical. Our specimens, while being generally pointed beneath (sometimes even showing a minute papilla or caudal prolongation) are very rarely pointed above, having at least a flattened apex (lat. 3—4μ) and sometimes a slight prominence of the same width. Almost all forms of *Lepocinclis* have a pair of discus-shaped paramylum plates closely appressed to the inner surface of the cell-wall. In this species, by continual deposition of fresh material, these gradually grow round the cell, and meet with a vertical line at each side; the central space of each plate fills up at the

same time, till only a horizontal line marks its position, and thus the two plates form a single broad band of paramylum all round the middle of the cell. In front view this band shows as three faint lines simulating the equator and tropics on a geographical globe.



Text-fig. 3.

(a.) Lepocinclis ovum (Ehr.) Lemm. x 1200; *(b.c.) L. ovum* var. *australis*, n. var. x 1200; *(d.) L. ovum* var. *costata*, n. var. x 1200; *(e.f.) L. fusiformis* (Carter) Lemm. x 560; *(g.h.) ditto*, forma. x 800; *(j.) ditto*, var. *caudata*, n. var., face view. x 800; *(k.) ditto*, another specimen, ¾ face. x 800; *(l.) L. rugulosa*, n.sp. x 800; *(m.) ditto*, end view.

Long. 38—50, lat. 24—35, lat. apic. 3—4μ. Auburn (135); Guildford; Botany (17); Rookwood; Botanic Gardens, Sydney (137); Lismore (233, 236, 241, 295).

Var. CAUDATA, n.var. (Text-fig. 3*j*, *k*).

Forma magna, inferne caudâ longâ, superne bullâ conicâ vel rectangulari praedita.

Long. corp. 32—43, lat. 21—28; long. caud. 10—16, lat. max. 4μ. Lismore (242, 236, 259, 295).

A rarer variety with a long tail and generally some sort of anterior prominence, conical or rectangular.

LEPOCINCLIS STEINII Lemmermann.

This species has been erected by Lemmermann (Das Plankton schwedischer Gewasser, p. 123, notes) to include Stein's two figures of *Lepocinclis* (*Chloropeltis*) *ovum* (T. xix., f. 47, 48) which are too slender to be typical of that species. Stein, in his explanation of the plates, considers these as representing *Euglena zonalis* Carter, but Kent's figure of the latter (Infusoria, T. xx., f. 58, after Carter) seems to forbid this identification. I do not know this species, which appears to be an oval form, finely striate longitudinally, having some connection with the next form.

Var. SUECICA Lemmermann. (Pl. vi., fig.1).

Long. corp. 26, lat. 11; lat. ap. 3, long. caud. ad 3μ. Casino (189).

Cf. Lemmermann, *l.c.*, p. 123, T. i., f. 20. He gives the size as 24.5—26μ long. and 9.5—12μ broad. According to his figure the membrane is finely striate longitudinally with a slight spiral twist.

(?) LEPOCINCLIS SPHAGNICOLA Lemmermann. (Pl. vi., fig. 2).

Long. corp. 30—32, lat. 12; lat. ap. 3μ. Botany (109); Guildford (114); Lismore (197).

Founded on a form figured by O. Zacharias (Forsch. d. biol. Stat. z. Plon, x., p. 259, T. ii., f. 17) as *L. fusiformis* (Carter) Lemm. I have not seen a figure of this species and therefore am not at all certain about the identification of our specimens. The author (*op. cit.*, p. 124) describes it as oval with collar-shaped, produced anterior end, and distinctly projecting (?) hyaline hinder end, 33μ long and 12μ broad. These dimensions and specifications seem to suit our forms very well.

LEPOCINCLIS CYMBIFORMIS, n.sp. (Pl. vi., figs. 3, 4).

Forma cymbiformis, lateribus nunc deplanatis nunc arcuatis, sursum modice producta truncata, inferne acuminata.

Long. 30—34, lat. 8—11; lat. ap. c. 3μ. Lismore (225).

This species includes certain somewhat irregular boat-shaped forms, sides either flattened or arched; body a little produced above, truncate; acuminate behind. Membrane striate longitudinally?

LEPOCINCLIS CAPITATA, n.sp. (Pl. vi., figs. 5, 6).

Forma anguste fusiformis, superne et inferne paene aequaliter attenuata; anteriore producta truncata, maxime capitata; postice in caudam brevem acutam protracta. Membrana per longitudinem costata, costis c. 6—8 visibilibus.

Long. 45—60, lat. 10—14, lat. ap. 4μ. Botany (92, 142); Botanic Gardens, Sydney (150); Lismore (225, 260, 299).

A very pretty and distinct species characterised by its slender, regularly fusiform body, produced above into a truncately-rounded capitate prominence, and below into a short tail which continues the lines of the body. The membrane is costate longitudinally, 6—8 costae showing.

LEPOCINCLIS COSTATA, n.sp. (Pl. vi., figs. 7, 8).

Forma late-elliptica, fere ovalis; sursum levissime deplanata, haud producta; inferne caudâ brevissimâ triangulari praedita. Membrana costis 8—10 per longitudinem dispositis ornata.

Long. corp. 26, lat. 10—12, lat. ap. 3, long. caud. 3—4μ. Auburn (135); Guildford (146); Wyrallah; Lismore (236, 259, 293).

A broadly elliptical, practically oval form, without any anterior prominence (none observed at any rate), but slightly flattened in front; behind furnished with a very short triangular tail; membrane costate longitudinally, with 8—10 costae visible.

Var. OBESA, n.var. (Pl. vi., fig. 9).

Forma prae longitudinem crassior.

Long. corp. 26, lat. 14—15, lat. ap. 3, long. caud. 3—4μ. Lismore (242, 236, 237).

LEPOCINCLIS PAXILLIFORMIS, n.sp. (Pl. vi., figs. 10, 11).

Forma minima, corpore conico, fronte late rotundata, prominentiâ nullâ; postice attenuata, caudâ minutâ praedita.

Long. 20, lat. 8μ. Guildford (114); Pott's Hill (113).

A small *Lepocinclis*, somewhat conical in general shape, broadly rounded in front, narrowed behind and furnished with a short tail, no anterior prominence noted. A rare species.

LEPOCINCLIS RUGULOSA, n.sp. (Text-fig. 3*l*, *m*).

Forma cylindracea, polis late-rotundatis, lateribus parallelis; membrana striis (vel costis) obliquis spiralibus ornata. A vertice circulata, margine rugulosa.

Long. 25, lat. 15μ. Rookwood.

A small cylindrical form with straight sides and broadly rounded ends. Membrane striate obliquely and spirally either with coarse striae or fine costae. End view circular, the striae showing as about 15 small corrugations on the margin. I am a little doubtful about the genus, as I have no note on the cell-contents. The flagellum figured, however, is Euglenoid and not as in *Sphenomonas*, and the motion "continually revolving" agrees with *Lepocinclis*. Noted in quantity from Rookwood in 1910.

Genus TRACHELOMONAS Ehr.

A detailed account of the principal types of this genus occurring in our waters has already been given in "The Genus Trachelomonas" (These Proceedings, 1915). Here it will only be necessary, therefore, to describe forms noted since then, and to confirm those of rare occurrence by new records.

TRACHELOMONAS VOLVOCINA var. PLANKTONICA, n.var. (Pl. vi., fig. 12).

Forma collo exteriore distincto instructa. A distinct neck round the orifice is very rare in this species. Only noted twice, in both cases from water-supply samples.

Diam. 15; coll. lat. 3, alt. 2μ. Brisbane Water Supply; Sydney Water Supply (115).

Var. SCABRA, n.var. (Pl. vi., fig. 13).

Forma collo brevi; membrana aspera. The membrane is usually very smooth and shiny; in this form it is slightly rough with minute irregularities, not regularly granulate; a short neck present.

Diam. 12μ. Guildford (45).

Var. CORONETTA, n.var. (Pl. vi., fig. 14).

Forma ore membranâ lata circumcincto. A very pretty and distinct form. The lorica does not seem to be always perfectly spherical, but produced above a little. The orifice is surrounded by a delicate and somewhat irregular, membranous collarette which stands out at a wide angle, edges smooth. In one specimen the chloroplasts were very regular, distinct and strongly marked. They were of the usual Euglenoid type, viz., small circular discs, but this is the only occasion on which I have noted this in *Trachelomonas*. In this genus the chlorophyll is arranged in three different ways: (1) apparently regularly diffused through the outer layer of cytoplasm; (2) disposed in a few, large, oval discs, widely separated and often more or less of irregular shape; (3) irregularly reticulated in patches with connecting threads.

Diam. 16, coll. diam. 10μ. Lismore (365).

Var. PUSTULOSA, n.var. (Pl. vi., fig. 15).

Forma plerumque hyalina, collo nullo; membrana pustulis latis pulviniformibus, minute granulatis, vestita.

Diam. 12μ. Sydney; Lismore.

Lorica generally hyaline and covered with broad disc-shaped pustules which are themselves minutely granulate. About 6 pustules across the face.

TRACHELOMONAS BOTANICA var. BOREALIS, n.var. (Pl. vi., fig. 16).

Forma modice oblonga, collo lato divergente praedita; membrana punctata.

Long. 36, lat. 30½; lat. oris 8, papill. 4μ. Lismore (303).

A more oblong form than the type, with a wide dentate collarette round the orifice. The distinguishing mark of this species is the minute papilla at the hinder end. Only known hitherto from Sydney—*antea*, 1915, p. 9, Pl. i., f. 9.

TRACHELOMONAS OVALIS Playfair. (Pl. vi., figs. 17, 18).

Long. 23—35, lat. 19—23μ. Murwillumbah; Lismore (328, 350).

Out of weeds in a surface-water drainage ditch at Murwillumbah in quantity. It is a form rapidly developed where there is a current of water. The lorica is thin, smooth, generally colourless or almost so, and transparent. The figures show the chlorophyll disposed either in regular discs, or irregular reticulations.

TRACHELOMONAS TERES Maskell, forma. (Pl. vi., fig. 19).

Long. corp. 27, lat. 18; coll. lat. 4, alt. 3μ. Lismore (285).

Cf. Maskell, On Freshwater Infusoria, Trans. N.Z. Institute, vol. xx., N.S., 1887. *Tr. teres*, type, is long oval, with a slight collar round the orifice, membrane smooth—the author gives long. 35μ. This form is not quite typical, being more oblong in outline. Four different necks are given which have been noted in this form.

TRACHELOMONAS BULLA var. AUSTRALIS Playf. (Pl. vi., fig. 20).

Long. corp. 40, lat. 23; coll. long. 8, lat. 6μ. Centennial Park, Sydney (133).

Only previously noted from Lismore. This specimen makes our form practically equal in size to Stein's type ($50 \times 21\mu$), but the shape is different.

TRACHELOMONAS OBLONGA Lemmermann. (Pl. vi., fig. 21).

Noted both with and without a neck. This is what I take to be Lemmermann's type, but I have not seen the figure.

Long. 17, lat. 12; coll. long. 2½, lat. 1½μ. Centennial Park (133).

TRACHELOMONAS PULCHERRIMA var. MINOR Playf. (Pl. vi., fig. 22).

Long. 17—19, lat. 10μ. Plenty in the swampy corner of a field in company with *Tr. pusilla* Playf. Lismore (344).

TRACHELOMONAS VOLZII var. SULCATA, n.var. (Pl. vi., fig. 23).

Forma parte anteriore sulcis 10—12 (5—6 visis) per longitudinem dispositis ornata.

Long. 31—32, lat. 21; lat. coll. 3, alt. 1½μ. Botany (108).

A form having the shape of the type, but with 5 or 6 sulcae running down the face as far as the centre. Var. *pellucida* and var. *cylindracea*, previously known from Sydney only, are here recorded from Lismore also (328, 358).

TRACHELOMONAS AMPULLULA var. MAJOR Playf. (Pl. vi., fig. 24).

Forma scrobiculata, lateribus minime angulatis, postice haud mammillata.

Long. 34—36, lat. 17—19; coll. alt. 2—3, lat. 5μ. Lismore (344).

This large form of *Tr. ampullula* is not always retuse and mammillate as previously described (*antea*, 1915, p. 17, Pl. ii., f. 7). In this case also the membrane was coarsely but faintly scrobiculate, and the general outline only very slightly angular.

Var. GRACILIS, n.var. (Pl. vi., fig. 25).

Forma major sed gracilior, lateribus levissime arcuatis, haud angulatis.

Long. 40, lat. 15; coll. alt. 3, lat. 4μ. Guildford (70).

A slender form of var. *major*, with arched, not angular sides, the mammillate end very distinct.

Var. ELLIPTICA, n.var. (Pl. vi., fig. 26).

Forma parva, gracillima, corpore perfecte elliptico, pone acute rotundato, lateribus haud angulatis.

Long. 25½, lat. 10½; coll. alt. 2½, lat. 2½μ. Lismore (350).

A very graceful elliptical form, acutely rounded behind and absolutely without any angularity. Clear pale yellow membrane.

TRACHELOMONAS CLAVATA var. SUBARMATA Playf. (Pl. vi., fig. 27).

Long. 58, lat. 22; coll. alt. 9, lat. 7½μ. Lismore (351).

A very rare and curious species, only known previously from the Botanic Gardens, Sydney, but now recorded from Lismore. The surface of the lorica was reticulate, however, not scrobiculate. I have seen but 3 specimens of this species and only 2 of var. *subarmata*; it is interesting to note that, however bizarre in appearance and rare in occurrence a form may be, it will keep its distinguishing characteristics wherever it is found.

TRACHELOMONAS EURYSTOMA var. PARVA, n.var. (Pl. vi., fig. 28).

Forma quam typicâ dimidio minor, magis rotunda, minime ovata, membrana glabra, striis nullis nec punctis.

Long. 13½, lat. 11; coll. lat. 4μ. Lismore (197).

A small rounded form, about half the size of the type, hardly ovate at all, obtained from weeds in the Richmond River. The membrane is smooth, not striate, and the ring-neck not fluted.

TRACHELOMONAS CORONATA, n.sp. (Pl. vi., figs. 29, 30).

Forma ovalis, vel ovata pone attenuata; superne collo latissimo divergente, margine cuspidato, coronata; inferne caudâ brevissimâ rectangulari bidentata praedita.

Long. 36—38, lat. 20—21; coll. alt. 2—4, lat. 12μ. Lismore (328).

The lorica is oval, or ovate narrowed posteriorly. Above, furnished with a wide outstanding collarette in form of a crown, with a cuspidate margin; below, a very short, square, bidentate tail. Membrane smooth or very slightly roughened.

TRACHELOMONAS SPLENDIDA, n.sp. (Pl. vii., fig. 1).

Lorica magna, elliptica; sursum collo quadrato, ore everso, inferne caudâ brevissimâ subrectangulari; membrana granulata.

Long. corp. 40, lat. 20; coll. alt. 6, lat. 5; caud. long. 6, lat. 1½μ. Lismore (365).

A large handsome species with a long-oval or elliptical body, square neck with everted rim, and short, subrectangular, stubby tail. Membrane dark yellow, granulate. The zooid was alive and active; the chlorophyll seemed to be diffused through the outer layer of the cytoplasm. The latter must have been very translucent, for in spite of the yellow colour and granules of the lorica, the internal organization of the zooid could easily be seen, which is rare in this genus.

This is one of my very latest finds; I thought I had exhausted the possibilities of the district, but the number and variety of types in *Trachelomonas* seem to be infinite.

TRACHELOMONAS HISPIDA (Perty) Stein.

Long. s.sp. 32—50, lat. s.sp. 23—33; spin. long. 4—6μ. Botany (92, 142); Lismore (333).

Of much larger dimensions than the type which is not over 30 × 20μ without spines; and spines only 2μ long.

TRACHELOMONAS BACILLIFERA Playf.

Long. s.sp. 35, lat. 32; spin. long. 2μ. Lismore (347).

Hitherto known only from Sydney; lorica almost spherical and very dark reddish-yellow in colour.

Var. MINIMA Playf. (Pl. vii., fig. 2).

Long. s.sp. 12½, lat. 10½; spin. long. 2μ. Lismore.

Only about half the size of the specimens previously recorded (Genus Trachelomonas, p. 22). It should be noted that in all the forms of *Tr. bacillifera* figured there, the spines are too fine, they should be much coarser, and not so many on the lorica, yet still quite close together.

Var. GLOBULOSA, n.var. (Pl. vii., fig. 3).

Forma sphaerica minuta. Diam. s. spin. 11μ. Brisbane.

A minute spherical form of a pale biscuit colour from the Brisbane water-supply. Such a tint is unusual in this species, all its forms being very dark coloured.

TRACHELOMONAS ARMATA var. GLABRA Playf. (Pl. vii., fig. 4).

Forma corpore ovato subgloboso nec oblongo.

Long. corp. 32, lat. 26μ. Lismore (365).

This specimen is the shape of Ehrenberg's type—ovate subglobose, slightly narrower in front than behind,—quite smooth, however, except for the posterior ring of awns. The chloroplasts and cytoplasm were reticulate.

Var. LONGISPINA Playf.

Long. corp. 42, lat. 32; spin. poster. long. 17, lat. max. 42μ. Lismore.

A fine specimen noted alive. The lorica was hispid with fine short spines (2μ long) and was armed behind with a ring of 10 long awns. Previously recorded only from Sydney and with no more than 4 posterior awns. For figure take that of var. *duplex* (Pl. vii., f. 5) without the subapical ring of awns. This is the first specimen of *Tr. armata* which agreed with Ehrenberg's type in being "hispid."

Var. DUPLEX Playf. (Pl. vii., fig. 5).

Forma spinis brevibus hispida (nec granulata); aculeis anterioribus acutis nec bacillaribus; aculeis posterioribus longissimis.

Long. corp. 45, lat. 35; acul. poster. long. 24μ. Lismore (332, 347, 365).

Var. *duplex* is very rare, as yet only found at Lismore. In this form the lorica is hispid with fine short spines, and not granulate. The awns of the anterior series are acute, not bacillar.

TRACHELOMONAS LISMORENSIS var. MIRABILIS Playf.

Diam. corp. s. spin. 25—26; spin. long. 5—6μ. Lismore (260, 261, 351).

My original description of this form gave only the end view. I can now state that the lorica is globose, differing in this from other forms of the species. Indeed it is doubtful if it should be placed under *Tr. lismorensis*, as the spines are characteristic, stout, conical, very closely set at equal distances apart and not in rows, 7—8 visible in a quadrant of the circumference, the outer half hyaline. (Pl. vii., f. 22).

Var. BISERIATA Playf.

Diam. corp. s.sp. 15; sp. long 3μ. Wyrallah (310); Byron Bay; Lismore (311, 328, 344, 347).

All the varieties of this species are remarkably regular in size and shape. This form is now confirmed from several localities in the district.

TRACHELOMONAS PAUCISPINOSA, n.sp. (Pl. vii., fig. 6).

Lorica subglobosa ubique rotundata; collo nullo; membrana glabra lutea, spinis brevibus validis acutis sparsis armata.

Long. s. spin. 17½, lat. 16; spin. long. c. 2½μ. Lismore (261).

A smooth subglobose or very broadly oval form, armed with short, sharp, stout spines, very wide apart—only 5 or 6 are visible at each side. A very rare species.

TRACHELOMONAS SCABRA var. CORDATA Playf. Forma. (Pl. vii., fig. 7).

Forma magis ovata, inferne magis angustata, membrana fere glabra.

Long. 20, lat. 15μ. Lismore (351).

A more ovate form than that described before and more narrowed below. Membrane only very slightly rough with low scattered thickenings here and there (*antea*, 1915, p. 29, Pl. iv., f. 11).

TRACHELOMONAS ACUMINATA var. AMPHORA Playf. (Pl. vii., fig. 8).

Long. 38, lat. 23; coll. alt. 8, lat. 6; caud. long. 10μ. Lismore (347).

Described originally from Parramatta, now confirmed from Lismore. The zooid was alive and active, the chlorophyll seemed to be diffused.

TRACHELOMONAS URCEOLATA Stokes. (Pl. vii., fig. 9).

Long. 50—57, lat. 23—28; coll. alt. 4—6; caud. long. 10—17μ. Lismore (347, 348, 352).

Merely a single specimen, not too like the type, was previously noted from Parramatta (Sydney), but I have now to record typical specimens alive in some quantity from this district. In most of the tailed forms the zooid is free within the lorica, but occasionally the body is adherent. Such are generally found in plankton gatherings and I would remark that it is not necessary to go for plankton to large bodies of water; the plankton of ponds is usually extremely varied and interesting.

TRACHELOMONAS GIRARDIANA mihi.

Syn. *Tr. urceolata* var. *Girardiana* Playf. (These Proceedings, 1915, p. 32, Pl. v., f. 7, 8). This form is really not in the least like *Tr. urceolata* and always retains its very characteristic appearance so that I think it should stand as a type.

Var. GLABRA, n.var. (Pl. vii., fig. 10).

Long. 36—40, lat. 20—22; coll. alt. 4—6, lat. 6; caud. long. 5—10μ. Lismore (347).

Membrane smooth in these specimens, not scabrous as formerly. At present known only from Lismore.

TRACHELOMONAS ELEGANTISSIMA (G. S. West) Playf.

Arranged, but doubtfully, by G. S. West as (?) *Dinobryon elegantissimum* in Algae of the Yan Yean Reservoir, p. 81, fig. 10K; I placed this species under *Trachelomonas* on account of the resemblance of a similar form to *Tr. napiformis*. The zooid, however, which alone can decide the genus, has not yet been noted; and indeed it is not at all unlikely that it may turn out to be a species of *Salpingoeca* (*antea*, 1915, p. 32, f. 12).

TRACHELOMONAS HESPERIA, n.sp. (Pl. vii., fig. 11).

Forma ad *Tr. elegantissimam* var. *ovatam* valde accendens, sed stipite brevissima; corpore ovato, subgloboso, utrinque rotundato, inferne acuminato, in stipitem brevissimam producto, superne collo rectangulari, ore everso.

Long. corp. 14, lat. 8; coll. alt. 4, lat. 4; stip. long. 2μ. Perth Water Supply, W. Australia.

A good many specimens of this form were found in a sample kindly sent me by the engineer of the Perth (W.A.) Water Supply. It is very like *Tr. elegantissima* var. *ovata* from the Sydney Water Supply, but with a very short stalk. The lorica is ovate, subglobose with rounded sides, narrowed below into a short stipes. Above there is a square neck with everted rim. Membrane smooth, that of the body stout, especially above, pale brown; but, in every case, that of the neck was hyaline and very delicate, evidently a later growth. One specimen noted was entirely hyaline, pellucid and thin-walled like a *Dinobryon*.

TRACHELOMONAS NAPIFORMIS var. BREVICOLLIS, n.var. (Pl. vii., figs. 12—14).

Forma paullo magis ovata, collo breviore, ore valde everso.

Long. 48—53 (corp. 36—38), lat. 24—25; coll. alt. 5—6, lat. 6—11; caud. 10—14μ. Lismore (322, 333, 347).

A more perfectly ovate form of the type with shorter neck and accentuated rim. A new record for this species.

TRACHELOMONAS CUNEATA, n.sp. (Pl. vii., fig. 15).

Lorica trapezoidea, angulis lateralibus fere rectis; inferne cuneata, lateribus planis ad caudam convergentibus; sursum subtriangularis, lateribus convexis in collum sensim sensimque adscendentibus, ore everso; membrana hyalina scabra.

Long. 50, lat. 20; coll. lat. 6; caud. long. 14μ. Lismore (258).

Lorica somewhat trapezoid with lateral angles almost square. Greatest breadth about 1-3rd from the mouth. From the lateral angles downward, cuneate, with flat sides converging to the tail. Above subtriangular, sides convex, gradually rising into the narrowed neck with everted rim; membrane irregularly roughened.

TRACHELOMONAS GIBBEROSA var. LONGICOLLIS, n.var. (Pl. vii., fig. 16).

Lorica corpore multo compresso; collo longissimo, lateribus parallelis.

Long. 54, lat. 26; coll. alt. c. 18, lat. 6; caud. long. c. 24μ. Lismore (258).

An elegant form, with the body of the lorica much compressed anteroposteriorly, and with a very long neck. This form and the previous one are both uncommon; they were plentiful, however, alive in one gathering.

Var. TUMIDA, n.var. (Pl. vii., fig. 17).

Lorica corpore prae longitudinem multo majore; collo vix formato; cauda minutissima.

Long. 53, lat. 39; lat. oris 7; caud. long. 3μ. Lismore.

A form in which the body of the lorica is very large compared with the total length. Above, it is gradually narrowed to the mouth without any distinct neck; tail quite minute. That polymorphism in these and similar organisms is largely a matter of the relative development of component parts, is well exemplified in this species. This form, var. *longicollis*, and the type (long. 53, 54, 56μ respectively) are all about the same size and the characteristic shapes are merely the result of the proportionate growth of the body, neck and tail of the lorica.

TRACHELOMONAS ROTUNDATA mihi. (Pl. vii., fig. 18).

Tr. gibberosa var. *rotundata* Playf., *antea*, 1915, p. 35, (var. *rotunda*, by a slip of the pen, in the explanation of the plates, p. 41).

Long. 40 (corp. 25); lat. 25; coll. alt. 6, lat. 6; caud. long. 9μ. Lismore.

This form retains its shape well and is not at all like *Tr. gibberosa*. I erect it here as a separate type. Specimens a little larger than those from Parramatta; a new record for the species.

TRACHELOMONAS LANCEOLATA, n.sp. (Pl. vii., figs. 19, 20).

Lorica lanceolata, lateribus rotundatis; sursum collo quadrato; inferne sensim sensimque attenuata, acuminata; a latere interdum compressa. Membrana glabra.

Long. 30, lat. 12—13; coll. alt. 4, lat. 5—6μ. Parramatta (136); Lismore (258).

Lanceolate with rounded sides, above converging to the wide square neck, below gradually running down to a point; membrane smooth. The Parramatta specimen was slightly compressed in side view.

TRACHELOMONAS SPIRALIS, n.sp. (Pl. vii., fig. 21).

Lorica elliptica, inferne acuminata, lateribus aequaliter arcuatis, sursum collo, lato, humili instructa. Membrana hyalina glabra, tenuissima, torta; costis spiralibus 3—4 ornatis.

Long. 36, lat. 21; coll. alt. 3, lat. 6μ. Botany (151).

Lorica elliptic, pointed below, sides evenly arched, neck wide and low; membrane very thin, hyaline and with the delicate matt or frosted surface common in this class of *Trachelomonas*. It belongs to the stipitate group, though it has no tail. Three or four ridges run spirally from end to end, the lorica having probably been an adherent form which has got twisted in growth. The tail itself in these forms is due to twisting, as a close examination will often show.

Fam. ASTASIACEAE.

Genus MENOIDIUM Perty.

MENOIDIUM PELLUCIDUM Perty. (Pl. viii., fig. 1).

Long. 40—50, lat. 12—16, ap. 3μ. Rookwood; Lismore (285, 350).

MENOIDIUM INFLATUM mihi. (Pl. viii., fig. 2).

Forma plana, levissime arcuata, fronte et postice acuta; rostro minuto angustissimo; cytoplasmate plerumque homogeneo, granulis amylaceis millis.

Long. 50—63, lat. 10—12μ. Coogee; Botany (92); Guildford (60); Sydney Water Supply.

Syn. *M. pellucidum* var. *inflatum* Playf., Plankt. Sydney Water, p. 547. More common round Sydney than any other species, not noted yet at Lismore. It is flat like a piece of card, acutely pointed at each end, under side nearly flat, upper arched but not always as much as figured. Rostrum reduced to a mere spine, but from Stein's figures it seems likely that this is only the lower edge of the rostrum, the upper edge growing out of the body,. a little higher up, later on. Cytoplasm generally homogeneous, without granules.

MENOIDIUM ACUTISSIMUM, n.sp. (Pl. viii., fig. 3).

Forma longissima, angustissima; fronte truncata, haud rostrata; pone longe protracta, acutissima; latere inferiore fere recto, superiore quam levissime arcuato; pharynge distincto; stigmate minutissimo; bacillis amylaceis longis angustis in serie singula dispositis ornata.

Long. 200, lat. 8½, ap. 5μ. Lismore; Wyrallah.

A very rare *Menoidium*, but noted from two distinct localities. The body is straight and very long in proportion to the breadth. No distinct rostrum in front, where it is merely narrow and truncate, but the formation and flagellum are as in *Menoidium*. The under side is nearly flat, the upper very slightly arched, the sides diverging slightly from the snout to the anterior quarter, from there gradually converging to the extremely narrow and sharp-pointed hinder end. Cytoplasm hyaline, homogeneous, transparent, allowing a clear view of the bag-shaped pharynx with which are connected a minute c.v. and red stigma. A single series of long thin paramylum rods along the upper side, much more regular than is usual in this genus.

MENOIDIUM GRACILE, n.sp. (Pl. viii., figs. 4, 5).

Forma magna, corpore gracili, arcuato, postice acuminato, fronte rostrato; cytoplasmate plerumque granulato et bacillis amylaceis ornato.

Long. 72—100, lat. 6—8; marg. infer. alt. 6—12μ. Botanic Gardens, Sydney (150); Lismore (225, 260, 350).

Nearly twice as long as the type. Body well-arched, very slender, acuminate but not acute behind, *rostrate in front*. Cytoplasm generally granulate and with a few paramylum rods in front.

MENOIDIUM INCURVUM Fresenius. (Pl. viii., fig. 6).

Syn. *M. pellucidum* var. *incurvum*, Biol. Richmond River, p. 141. A very small form and rare, though there were plenty in gathering 188 out of weeds in the Richmond River. Broadest in front where it is abruptly truncate, without rostrum, and very active in its movements, darting and twisting about incessantly; there is very little in its appearance to connect it with this genus.

Cf. Klebs, Organ. einig. Flag.; and Daugeard, Recherch. s. l. Euglen., p. 151, f. 46; the latter gives 25 × 7μ as the size.

Long. 16, lat. 5μ. Lismore (188, 358).

MENOIDIUM TORTUOSUM (Stokes) Senn. (Pl. viii., fig. 7).

Syn. *Atractonema tortuosum* Stokes, Infus. U.S. p. 92, Pl. i., f. 31. A narrow spiral form, rostrate in front, acutely pointed behind; cytoplasm homogeneous, with a few paramylum granules or short rods. It moves in a spiral manner, unlike other members of the genus, which either revolve slowly round the long axis or *bore* their way through the water, rocking from side to side in a manner peculiarly their own.

Long. c. 22, lat. 5μ. Stokes gives long. 20—40μ. Lismore (350, 365).

Genus DISTIGMA Ehr.

DISTIGMA PROTEUS var. CLAVATUM mihi. (Pl. viii., fig. 8).

Syn. *Menoidium pellucidum* var. *clavatum* Playf., Biol. Richmond River, p. 142. *Cf.* Senn, Flagellata, pp. 177, 178, f. 128B.

Long. 40—84, lat. 6—12μ. Lismore (187, 188, 365).

Formae. (Pl. ix., figs. 10—13).

These forms have all the appearance of being a distinct species of *Peranema*, but I believe them to be young forms of the preceding.

Long. 18—44, lat. max. 8—12μ. Auburn (139); Pott's Hill (121); Lismore (258).

Genus ASTASIA Dujardin.

ASTASIA MARGARITIFERA Schmarda. (Pl. viii., fig. 9).

I am doubtful about the identification of this infusorian, having never observed it in the free-swimming form figured by Senn, *l.c.*, p. 177, f. 128A. Only when travelling with its characteristic metabolic movement does it draw one's attention, and so I represent it here. The flagellum is very often (generally?) wanting; cytoplasm granulate. On one occasion half a dozen individuals were found living parasitically within the tissues of a living specimen of the *Turbellaria;* they were devoid of a flagellum and worked themselves to and fro with their usual metabolic progression.

Long. c. 20—50μ. Auburn (139); Pott's Hill (121); Lismore (312).

Genus SPHENOMONAS Stein.

SPHENOMONAS QUADRANGULARIS var. CRUCIFORMIS, n.var. (Pl. viii., fig. 10).

Ovate, pointed in front; with four, more or less elevated, longitudinal ridges each containing at the summit a series of granular markings. The European form (type) is rhomboidal in outline, with rounded lateral angles; in end view almost square, with slightly cuspidate sides and sharp angles. Ours are cruciform with deeply excavated sides and rounded tips to the arms. Rare. For the type *see* Stein, T. xxiii., f. 49—53; Kent, T. xxiv., f. 21—23.

Long. 24—27, lat. 10—13μ. Rookwood (107); Lismore (297, 345, 347).

SPHENOMONAS AUSTRALIS, n.sp. (Pl. viii., fig. 11).

Cellulae pyriformes, sursum attenuatae, subacutae; inferne rotundatae; lateribus arcuatis; rugis 6 (visis 4) granulatis per longitudinem dispositis ornata. Vertice visae hexagonae lateribus emarginatis.

Long. 25—26, lat. 10—12μ. Rookwood; Botanic Gardens, Sydney (156); Lismore (312).

This species is more frequently met with here than any other of the genus. It is drop-shaped, narrowed and subacute in front, rounded behind. End view hexagonal, as the body is ornate with 6 longitudinal granulate ridges. The hinder part of the body is generally a solid ball of some perfectly transparent highly refringent substance (leucosin ? or paramylum ?). So homogeneous and pellucid is it that the granules on the under side can be seen, magnified, through it.

Var. ELLIPTICA, n.var. (Pl. viii., fig. 12).

Cellulae longe-ovatae, paene ellipticae, fronte acuminatae, postice rotundatae, lateribus levissime arcuatis. Dimensiones ut in f. typica. Rookwood (107).

A much less common elliptic form of similar size and characteristics to the type.

Var. RHOMBOIDEA, n.var. (Pl. viii., fig. 13).

Cellulae rhomboideae, lateribus angulatis, utroque polo acuminatae.

Long. ad. 30, lat. 16μ. Guildford (45).

The cells are rhomboidal, sides angled, ends subacutely rounded.

SPHENOMONAS TERES (Stein) Klebs. (Pl. viii., figs. 14, 15).

Syn. *Atractonema teres* Stein, *op. cit.*, T. xxiii., f. 35—41; *Clostenema socialis* Stokes, *op. cit.*, p. 112, Pl. ii., f. 15. Almost, if not quite, as common as the foregoing species. Senn, *l.c.*, p. 177, f. 128D, figures it with only an incipient trailer (the secondary flagellum), but I find specimens with a trailer twice the length of the body, and young forms have no second flagellum at all. The fact is that the trailer develops later than the true flagellum. The latter is of the *Peranema*-type, stout at the base and tailing off to the tip. It is held motionless for the most part, straight out in front; only the tip is in movement. Sometimes the extreme end of the cell is constricted into a little stubby tail.

Long. 20—25, lat. 6—12μ. Auburn (139); Lismore (298, 312, 345).

Var. PYRIFORMIS, n.var. (Pl. viii., figs. 16, 17).

Cellulae ut in *f.* typica rugis nullis, sed pyriformibus, interdum caudâ brevi subtriangulari instructae.

Long. 16—26, lat. 9—20μ. Auburn (140); Botany (91); Lismore (188, 298, 312).

Smooth and without ridges as in the typical form, but in shape pyriform, with or without a short broad tail.

It is probable that *Sph. teres* is a young form or at least a polymorphic form of *Sph. australis*. I have noted faint longitudinal lines down the body, which seemed to indicate the formation of ridges. In Pl. viii., fig. 18, is shown an intermediate form in which the ridges are plainly visible, but the characteristic marginal granulation was not present and the cell therefore inclined to *Sph. teres*.

SPHENOMONAS TRIQUETRA, n.sp. (Pl. viii., fig. 20).

Cellulae inaequaliter ovatae, utroque polo acuminatae; a vertice visae inaequaliter triquetrae.

Long. 30, lat. 20μ. Rookwood; Botanic Gardens (156).

Irregularly ovate in shape, pointed at each end, with a ridge running spirally down the face; end view irregularly triangular with hollow sides and rounded angles.

Var. CUNEATA, n.var. (Pl. viii., fig. 19).

Cellulae inaequaliter cuneata, fronte rotundatae, postice attenuatae, acuminatae; a vertice visae inaequaliter triquetrae.

Long. 30, lat. 15μ. Guildford.

Somewhat cuneate in shape, broadest in front, where it is rounded off, gradually narrowed to a subacute point behind. A longitudinal ridge down the face; end view irregularly triangular with hollow sides and rounded angles.

SPHENOMONAS EXCAVATA, n.sp. (Pl. ix., fig. 1).

Cellulae oblongae, subrectangulares; extremitatibus lateribusque arcuatis; utroque polo bullâ conicâ praeditae; rugis 3, mediano spirale, per longitudinem dispositis instructae; flagello recto. A vertice visae subrectangulares, utrinque rugis altis 3. A latere late-fusiformes.

Long. 32, lat. 21, crass. c. 16μ. Lismore (358).

Subrectangular, ends and sides arched; at each pole a conical boss, from the anterior part of which the straight thick *Peranema* flagellum springs. No

trailer noted. Three deeply excavated longitudinal ridges run down both the upper and under face, the central one somewhat spiral. End view subrectangular, with 3 strongly marked ridges front and back, the other two sides slightly hollowed. Side view broadly fusiform or lenticular. Membrane smooth; cytoplasm hyaline, transparent, homogeneous. No paramylum, no granulation of the ridges.

SPHENOMONAS SPIRALIS, n.sp. (Pl. ix., fig. 2).

Cellulae ambitu late-fusiformes, superne acutae, inferne obtusae; rugis spiralibus 5—6 paene transverse dispositis alte excavatae; membrana glabra; cytoplasmate retracto, granulato, hyalino; flagello recto, crasso, interdum secundo *retrorsum directo.*

Long. 40, lat. 34μ. Botanic Gardens, Sydney (156).

Broadly lenticular in general outline, pointed above, obtuse below, deeply scored by 5 or 6 spiral ridges laid almost horizontally and from left to right. Membrane smooth; cytoplasm retracted, hyaline, granular; a stout flagellum directed straight forward, sometimes also a trailer.

Var. ANGUSTA, n.var. (Pl. ix., fig. 3).

Cellulae ambitu longe-ovales; utroque polo obtusae infra marginem spinâ praeditae; rugis spiralibus 3—4 oblique dispositis alte excavatae; cytoplasmate haud retracto; ceteris ut in forma typica.

Long. 40, lat. 21μ. *Lismore.*

General outline long oval; obtuse at each end, with a sharp point within the margin; only 3—4 ridges spirally and obliquely wound; cytoplasm not retracted; a flagellum and a trailer observed.

SPHENOMONAS MIRABILIS, n.sp. (Pl. ix., figs. 4, 5).

Cellulae oblongae, utroque polo rotundatae; costis spiralibus 6 oblique vel per longitudinem dispositis ornatae; membrana glabra, costis haud granulatis; cytoplasmate retracto, hyalino, granulato; flagello valido recto.

Long. 34—36, lat. 18—23μ. Lismore (328, 345, 365).

Cell oblong, rounded at each end; membrane smooth, ridged by 6 sharp-edged spiral costae longitudinally and more or less obliquely wound and from right to left (the opposite way to *Sph. spiralis*). Cytoplasm retracted, hyaline, granulate, flagellum stout, straight, no trailer noted. End view circular.

Fam. PERANEMACEAE.

Genus PERANEMA (Ehr.) Stein.

PERANEMA TRICOPHORUM (Ehr.) forma. (Pl. ix., fig. 6).

Forma angusta arcuata. Long. 50, lat. 10μ.

I doubt if I have ever seen the type of this species. The European form is fusiform. The specimen figured is narrower and arched. Botanic Gardens, Sydney (156). *Cf.* Senn., p. 180, f. 130A.

PERANEMA CUNEATUM, n.sp. (Pl. ix., figs. 7—9).

Long. 25—70, lat. 5—15μ. Auburn (139, 140); Botanic Gardens (156); Parramatta (132); Lismore (187).

This is the common *Peranema* of our waters. It is, when free-swimming, cuneate, sharp-pointed in front and abruptly truncate behind; one corner is sometimes produced as a pointed tail directed backwards, or a blunt wart-like prominence often bifid and placed to one side. A minute stigma may occasionally be observed. Cytoplasm homogeneous and transparent. Neither Stein nor Dujardin describe or figure anything even remotely resembling this form. The body is metabolic.

PERANEMA ASPERUM, n.sp. (Pl. ix., fig. 14).

Forma corpore globoso; granulis amylaceis ubique asperrima.

Long. 15—16, lat. 11—12μ. Rookwood; Lismore (286).

A small, irregular, globose or subglobose form with the surface rugged all over with large irregular amylaceous granules.

Var. RECTANGULARE, n.var. (Pl. ix., fig. 15).

Forma cylindracea. Dimensiones ut in forma typica.

Genus URCEOLUS Mereschowski.

URCEOLUS SABULOSUS (Stokes) Senn. (Pl. ix., fig. 16).

Syn. *Urceolopsis sabulosus* Stokes, *op. cit.*

Long. 42, lat. 19; lat. oris 13μ. Lismore.

Hyaline, granular, surface slightly rough, mouth and neck smooth. It glides along applying the huge mouth (which seems to be a kind of open pharynx) to the floccose and sucking in anything edible.

Genus HETERONEMA (Duj.) Stein.

HETERONEMA ACUS Ehr. (Pl. ix., fig. 17).

Long. 30—90, lat. 3—6μ. Auburn (159); Botany; Pott's Hill (121).

Flagellum and trailer noted.

Genus TROPIDOCYPHUS Stein.

TROPIDOCYPHUS OCTOCOSTATUS Stein. (Pl. viii., fig. 21).

I give a side view of an animalcule that may be this species. Stein, T. xxiv., f. 1—5; Senn, p. 183.

Genus NOTOSOLENUS Stokes.

NOTOSOLENUS PENTAGONUS, n.sp. (Pl. ix., figs. 2, 3).

Forma corpore pentagono; fronte acute-rotundata, pone truncata; lateribus emarginatis; angulis rotundatis; vertice visa compressa.

Long. 21, lat. 17μ. Lismore (358).

There are three other species described and figured by Stokes, *op. cit.*, p. 108, Pl. ii., f. 10—14; *cf.* Senn, p. 183. All forms of the genus are compressed arcuate in end view. This species forms a fairly regular pentagon with the anterior angle somewhat produced; body truncate behind, widest in the middle; sides emarginate, angles rounded. Cytoplasm hyaline, finely granular in the centre of the cell, with a pharynx-like mark below the flagellum. Stokes also remarks on this. Flagellum thick, straight, a long trailer sometimes present.

Genus Anisonema Dujardin.

Anisonema acinus Duj. (Pl. ix., fig. 18).

Syn. *Anisonema ovatum* Maskell, Trans. N.Z. Inst., N.S., vol. 20, 1887, T. i., f. 8; Maskell gives long 20μ. Our specimens agree entirely with Dujardin's figure and description (*op. cit.*, p. 345, Pl. iv., f. 27; not Pl. v. as in the text). Senn's figure (*Flagellata*, p. 183, f. 134A) is quite different, being elliptical and attenuate slightly to each end. Dujardin's dimensions, long. 20 to 31μ, just cover Maskell's and ours. The trailer is very long, quite three times the length of the body sometimes.

Long. 30, lat. 18μ. Rookwood; Lismore (260).

Anisonema hexagonum, n.sp. (Pl. ix., fig. 19).

Cellulae inaequaliter hexagonae; in medio subquadratae; sursum et inferne triangulari-conicae; utroque polo acutae; lateribus rectis; uno latere transverse striata.

Long. c. 30, lat. 18μ. Duck Creek, Clyde; Guildford.

Irregularly hexagonal, central part subquadrate; above and below triangular-conical, ends pointed, sides straight, transversely striate, apparently on one side only; flagellum and long trailer observed.

Var. elegans, n.var. (Pl. ix., fig. 20).

Quam forma typica longior et angustior.

Long. c. 40, lat. 10μ. Duck Creek, Clyde; Guildford.

The same general shape as the type, but longer and more slender. Both very rare, sizes only estimated.

Anisonema grande (Ehr.) Stein. (Pl. ix., fig. 21).

Long. c. 38, lat. 21, crass. c. 10½μ. Lismore (328).

Syn. *Bodo grandis* Ehr.; *cf.* Stein, T. xxiv., f. 6—11, but his figures are not convincing and look too much like *Anisonema acinus* Duj. which he gives as a synonym. That is, however, a much smaller species, only about half the size of this. Kent's figures are copies of Stein's, except f. 30 (after Butschli). The latter seems to represent our form. The subapical groove, in which the trailer is inserted, is not conspicuous as in *A. acinus*. The hinder part of the body often contains coloured masses of ingested food-stuffs and even whole organisms such as *Trachelomonas*. There is the usual stout straight flagellum and very long thick trailer, often three times the length of the body. The latter is compressed in side view.

Genus Entosiphon Stein.

Entosiphon sulcatum (Duj.) Stein. (Pl. ix., fig. 22).

Long. 22, lat. 14μ. Lismore. Rare.

Syn. *Anisonema sulcata* Duj., p. 345, Pl. iv., f. 28. Senn gives long. 15—25, lat. 7—15μ.

EXPLANATION OF PLATES I.—IX.

Plate i.

Fig. 1.—*Poteriodendron petiolatum* Stein (x 800).
Fig. 2.— ,, ,, var. *Abbotti* (Stokes) mihi (x 800).
Figs. 3, 4.—*Salpingoeca ampullacea* (A. Br.) Stein (x 1600).
Fig. 5.— ,, ,, var. *cordata*, n. var. (x 1600).
Fig. 6.— ,, *amphoridium* var. *australica* mihi (x 1600).
Fig. 7.— ,, *Steinii* Kent (x 1600).
Figs. 8, 9.— ,, *oblonga* Stein (x 2400).
Fig. 10.—*Bodo edax* Klebs (x 2400).
Fig. 11.— ,, *saltans* Ehr. (x 2400).
Fig. 12.—*Trepomonas agilis* Duj. (*a*) front, (*b*) side (x 2400).
Fig. 13.—*Hexamita inflata* Duj. (?) (x 2400).
Figs. 14, 15.—*Ochromonas aspera*, n.sp., (*a*) side (x 2400).
Fig. 16.— ,, *cylindracea*, n.sp., (*a*) side (x 2400).
Figs.17-21.—*Dinobyron sertularia* Ehr. (17, 19) two forms of lorica; (18) zooid; (20, 21) cysts; (all x 1200).
Figs. 22, 23.—*Dinobyron sertularia* var. *angulatum* Seligo, two forms, (x 1200).
Figs. 24, 25.— ,, *cylindricum* var. *divergens* (Imhof) Lemm. (x 1200).
Figs. 26, 27.— ,, *utriculus* (Ehr.) Klebs, two forms, (x 1600).
Figs. 28, 29.— ,, ,, var. *Tabellariae* Lemm., (28) five individuals joined by the discs of their pedicels (x 1600); (29) cyst (x 1200).

Plate ii.

Figs. 1, 2.—*Mallomonas acaroides* Perty; (1) young form, type (x 800); (2) mature form (x 1200).
Fig. 3.—*Mallomonas splendens* (G. S. West) Playf. (x 1200).
Fig. 4.— ,, ,, var. *pusilla*, n. var. (x 1200).
Fig. 5.— ,, *australica*, n.sp. (x 1600).
Fig. 6.— ,, ,, v. *gracillima*, n. var. (x 1600).
Figs. 7, 8.— ,, ,, v. *subglobosa*, n. var. two stages of growth, (x 1200).
Fig. 9.— ,, *litomesa* Stokes (x 1600).
Fig. 10.— ,, ,, var. *curta*, n. var. (x 1600).
Fig. 11.—*Phaeococcus planktonicus* W. & G. S. West (x 320) (*a*) simple zooid (x 960).
Figs. 12-14.—*Scintilla chlorina*, n.sp.; (12) x 2400, (13, 14) x 1600.
Fig. 15.— ,, *splendida*, n.sp. (x 800).
Figs. 16-18.—*Synura virescens* (Bory), three forms; (all x 1600).
Figs. 19-22.—*Chilomonas paramecium* Ehr., four forms; (all x 1600).
Fig. 23.—*Cryptomonas ovata* Ehr. (x 800).
Fig. 24.— ,, *ampulla*, n.sp. (x 800).
Fig. 25.— ,, *maxima*, n.sp. (x 800).
Fig. 26.— ,, *Nordstedtii* (Hausg.) Senn. (x 1600).
Fig. 27.— ,, *gemma*, n.sp. (x 1600).
Fig. 28.— ,, *oblonga*, n.sp. (x 1600).

Plate iii.

Fig. 1.—*Eutreptia viridis* Perty (x 560).
Fig. 2.—*Colacium vesiculosum* (Ehr.) Stein (x 1200).
Fig. 3.— ,, ,, forma, *cf.* Stein, T. xxi., f.31,32 (x 1200).
Figs. 4-6.— ,, *elongatum*, n.sp. (4) x 1200, (5,6) x 2400.
Fig. 7.—*Euglena viridis* Ehr., large cylindrical form (x 1200).
Figs. 8, 9.— ,, *sociabilis* Daugeard (x 800).
Figs. 10, 11.—,, *amblyophis* (Ehr.) mihi (x 400).
Figs. 12, 13.—,, *deses* Ehr. (13) another form of head (x 960).
Fig. 14.— ,, ,, developing out of the vegetative cell (x 800).

Fig. 15.—*Euglena deses* var. *minuta*, n. var. (x 1200).
Fig. 16.— „ „ var. *intermedia* Klebs (x 1200).
Fig. 17.— „ *oxyurus* Schmarda (x 300).
Fig. 18.— „ „ var. *helicoidea* (Bernard) mihi (x 300).
Fig. 19.— „ „ var. *gracillima*, n. var. (x 400).

Plate iv.

Fig. 1.—*Euglena tripteris* (Duj.) Klebs. (x 480).
Fig. 2.— „ *spirogyra* (Ehr.) (x 800).
Fig. 3.— „ „ with granules forming here and there (x 400).
Fig. 4.— „ „ var. *elegans*, n. var. (x 800).
Fig. 5.— „ *acus* Ehr.; our nearest form (x 600).
Fig. 6.— „ *acutissima* Lemm. (x 600).
Figs. 7, 8.— „ „ var. *parva*, n. var. (7) x 1200, (8) x 800.
Figs. 9-11.— „ *pisciformis* Klebs. (x 1200).
Fig. 12.— „ *texta* (Duj.) Senn, showing striae (x 800).
Fig. 13.— „ „ var. *ovata*, n. var. (x 960).
Fig. 14.— „ „ var. *obesa*, n. var. (x 525).
Figs. 15, 16.—„ „ var. *bullata*, n. var. (15) x 525, (16) x 1200.
Fig. 17.— „ *guttula*, n.sp. (x 1200).
Fig. 18.— „ „ var. *elongata*, n. var. (x 1200).
Fig. 19.— „ *vivida*, n.sp. (x 1800).
Figs. 20, 21—„ *pusilla*, n.sp. (20) x 1600, (21) x 1800.
Fig. 22.— „ „ var. *longa*, n. var. (x1200)
Fig. 23.— „ sp. ? (x 1200).

Plate v.

Fig. 1.—*Phacus pleuronectes* (Müller) Duj. (x 800).
Fig. 2.— „ „ var. *minutus*, n. var. (x 800).
Fig. 3.— „ „ var. *australis*, n. var. (x 480).
Fig. 4.— „ *hispidulus* (Eichwald) (x 1200).
Fig. 5.— „ *monilata* var. *suecica* Lemm. (x 1200).
Fig. 6.— „ *longicauda* (Ehr.) Duj. (x 400).
Fig. 7.— „ „ var. ——— Lemm. (x 800).
Figs. 8-11.— „ *triqueter* (Ehr.) Duj. (x 960).
Figs. 12, 13.—„ *inflatus*, n.sp. (x 1600)
Fig. 14.— „ *lismorensis*, n.sp. (x 960).
Fig. 15.— „ *pyrum* var. *ovatus*, n. var. (x 1600).
Fig. 16.— „ „ var. *australicus* mihi. (x 960).
Fig. 17.— „ „ var. *rudicula*, n. var. (x 1200).
Fig. 18.—*Cryptoglena australis*, n.sp. (*a*) side; (x 1600).
Fig. 19.— „ *phacoidea*, n.sp. (x 1800).

Plate vi.

Fig. 1.—*Lepocinclis Steinii* var. *suecica* Lemm. (x 1200).
Fig. 2.— „ *sphagnicola* Lemm. (?); (x 1200).
Figs. 3, 4.— „ *cymbiformis*, n.sp. (x 1200).
Figs. 5, 6.— „ *capitata*, n.sp. (5) x 1200, (6) x 800.
Figs. 7, 8.— „ *costata*, n.sp. (x 1600).
Fig. 9.— „ „ v. *obesa*, n. var. (x 1600).
Figs. 10, 11.— „ *paxilliformis*, n.sp. (x 800).
Fig. 12.—*Trachelomonas volvocina* var. *planktonica*, n. var. (x 1200).
Fig. 13.— „ „ var. *scabra*, n. var. (x 1200).
Fig. 14.— „ „ var. *coronetta*, n. var. (*a*) another collarette; (x 1600).
Fig. 15.— „ „ var. *pustulosa*, n.var (x 1200).

Fig. 16.—*Trachelomonas botanica* var. *borealis*, n. var. (x 800).
Figs. 17, 18.— ,, *ovalis* Playf. (17) with discoid chloroplasts, (18) chlorophyll irregularly reticulated (x 1200).
Fig. 19.— ,, *teres* Maskell, forma. *(a,b,c)* three other forms of collar (x 1200).
Fig. 20.— ,, *bulla* var. *australis* Playf. (x 800).
Fig. 21.— ,, *oblonga* Lemm. (x 1600).
Fig. 22.— ,, *pulcherrima* var. *minor* Playf. (x 1200).
Fig. 23.— ,, *Volzii* var. *sulcata*, n. var. (x 1200).
Fig. 24.— ,, *ampullula* var. *major* Playf.; a scrobiculate form with zooid. (x 1200).
Fig. 25.— ,, ,, var. *gracilis*, n. var. (x 1200).
Fig. 26.— ,, ,, var. *elliptica*, n. var. (x 1200).
Fig. 27.— ,, *clavata* var. *subarmata* Playf., a lorica with reticulate surface, and zooid. (x 1200).
Fig. 28.— ,, *eurystoma* var. *parva*, n. var. (x 1800).
Figs. 29, 30.— ,, *coronata*, n.sp. (x 1200).

Plate vii.

Fig. 1.—*Trachelomonas splendida*, n.sp. with zooid showing internal structure and diffused chlorophyll. (x 1050).
Fig. 2.— ,, *bacillifera* var. *minima* Playf. (x 1600).
Fig. 3.— ,, ,, var. *globulosa*, n. var. (x 1200).
Fig. 4.— ,, *armata* var. *glabra* Playf., showing zooid with reticulate chlorophyll. (x 960).
Fig. 5.— ,, ,, var. *duplex* Playf., form with pointed, not bacillar, anterior awns. (x 800).
Fig. 6.— ,, *paucispinosa*, n. sp. (x 1600).
Fig. 7.— ,, *scabra* var. *cordata* Playf. forma. (x 1600).
Fig. 8.— ,, *acuminata* var. *amphora* Playf. zooid with diffused chlorophyll. (x 960).
Fig. 9.— ,, *urceolata* Stokes with zooid. (x 800).
Fig. 10.— ,, *Girardiana* var. *glabra*, n. var. with zooid. (x 1200).
Fig. 11.— ,, *hesperia*, n.sp. (x 1600).
Figs. 12-14.— ,, *napiformis* var. *brevicollis*, n. var. (12) showing zooid, x 800. (13, 14) other forms of neck, x 1200.
Fig. 15.— ,, *cuneata*, n.sp. (x 1200).
Fig. 16.— ,, *gibberosa* var. *longicollis*, n. var. (x 1200).
Fig. 17.— ,, ,, var. *tumida*, n. var. (x 960).
Fig. 18.— ,, *rotundata* mihi. (x 960).
Figs. 19, 20.— ,, *lanceolata*, n.sp. (19) from Parramatta; (20) from Lismore (x 1200).
Fig. 21.— ,, *spiralis*, n.sp. (x 1200).
Fig. 22.— ,, *lismorensis* var. *mirabilis* Playf., characteristic spine.

Plate viii.

Fig. 1.—*Menoidium pellucidum* Perty, type. (x 1200).
Fig. 2.— ,, *inflatum* mihi. (x 800).
Fig. 3.— ,, *acutissimum*, n.sp. (x 600).
Figs. 4, 5.— ,, *gracile*, n.sp. (x 800).
Fig. 6.— ,, *incurvum* Fresenius (x 1800).
Fig. 7.— ,, *tortuosum* (Stokes) Senn, three specimens (x 800).
Fig. 8.—*Distigma proteus* var. *clavatum* mihi. (x 800).
Fig. 9.—*Astasia margaritifera* Schmarda. (x 1800).
Fig. 10.—*Sphenomonas quadrangularis* var. *cruciformis*, n. var. (*a*) end view. (x 1600).
Fig. 11.— ,, *australis*, n.sp.; (*a*) end view. (x 1600).
Fig. 12.— ,, ,, var. *elliptica*, n. var. (x 1600).
Fig. 13.— ,, ,, var. *rhomboidea*, n. var. (x 1600).

Figs. 14, 15.— ,, *teres* Stein (14) type x 2400; (15) form x 1900.
Figs. 16, 17.— ,, ,, var. *pyriformis*, n. var. (16) x 2400; (17) x 1600.
Fig. 18.— ,, ,, form, with incipient ridges. (x 1600).
Figs. 19, 20.— ,, *triquetra*, n.sp. (20) type x 1200; (19) var. *cuneata* n. var. x 1200. *(a, a)* end views.
Fig. 21.—*Tropidocyphus octocostatus* Stein (?) side view (x 1600).

Plate ix.

Fig. 1.—*Sphenomonas excavata*, n.sp. (*a*) side, (*b*) end (x 1200).
Fig. 2. ,, *spiralis*, n.sp. (x 960).
Fig. 3.— ,, ,, var. *angusta*, n. var. (x 960).
Figs. 4, 5.— ,, *mirabilis*, n.sp. (x 1200).
Fig. 6.—*Peranema tricophorum* (Ehr.), forms. (x 800).
Fig. 7–9.— ,, *cuneatum*, n.sp. (x 800).
Figs. 10–13.—*Distigma proteus* var. *clavatum* mihi, supposed young forms. (x 800).
Fig. 14.—*Peranema asperum*, n.sp. (x 1200).
Fig. 15.— ,, ,, var. *rectangulare*, n.var. (x 1200).
Fig. 16.—*Urceolus sabulosus* (Stokes) Senn. (x 800).
Fig. 17.—*Heteronema acus* Ehr. (x 800).
Fig. 18.—*Anisonema acinus* Duj. (x 1600).
Fig. 19.— ,, *hexagonum*, n.sp. (x 1600).
Fig. 20.— ,, ,, var. *elegans*, n. var. (x 1600).
Fig. 21.— ,, *grande* (Ehr.) Stein (*a*) side. (x 1200).
Fig. 22.—*Entosiphon sulcatum* (Duj.) Stein (x 1600).
Fig. 23.—*Notosolenus pentagonus*, n.sp. (x 1600).

ON THE OCCURRENCE OF *OTOZAMITES* IN AUSTRALIA, WITH DESCRIPTIONS OF SPECIMENS FROM WESTERN AUSTRALIA.

By A. B. Walkom, D.Sc.

(Plate x.)

Last year a collection of fossil plants from near Mingenew, W.A., was made available to me for examination through the kindness of Dr. W. G. Woolnough. Almost all the specimens in the collection represent species of *Otozamites,* a genus of rather limited occurrence in Australia, and this opportunity is taken, while describing these species, of gathering together the few records of the scattered occurrence of the genus in this Continent.

Among the Western Australian collection there are no new species, but some of the specimens are different from those previously described from Australia.

The only description of specimens of *Otozamites* from Western Australia is that by Arber (1910) who described *O. Feistmanteli* Zigno from about three miles south of Mingenew, at an altitude of about 500 feet above the town. He called attention to the possibility of identity between the Western Australian fronds and specimens from the Lower Oolite of Germany figured by Kurr as *O. Mandelslohi;* and also pointed out that examples figured under the same name by Salfeld (1907, Pl. xvi., figs. 1*a*, 1*b*, 1*c*) from the Lias of Wurtemburg do not appear to be identical with the Australian fronds.

The specimen from the Talgai Coalfield, Queensland, which Feistmantel (1890, p. 147, Pl. 28, fig. 9, 9*a*) had referred to *O. Mandelslohi* is, as Arber suggested (1910, p. 26), identical with some of the Western Australian examples, and should be referred to *O. Feistmanteli* Zigno. The original of Feistmantel's figure is in the collection of the Geological Survey of New South Wales, and, through the courtesy of Mr. W. S. Dun, Palaeontologist, I have been able to examine it.

In addition to *Otozamites Feistmanteli,* Arber also recorded the occurrence of indeterminable fossil wood fragments, of coniferous fragments, and of small seed-like bodies from the same locality. He suggested that the coniferous fragments might be compared with such forms as *Pagiophyllum Kurri* Schimper, *Araucaria (Pagiophyllum) peregrina* Kurr or the fragment figured by Tenison-Woods (1883, p. 165, pl. 4, fig. 1) as *Cunninghamites australis.*

In drawing up a table of fossil plants recorded from Western Australia, L. Glauert, unfortunately enters all three of these species (1910, p. 110) so that this single indeterminate fragment is represented in his table by three separate entries.

The specimens described in the present communication were obtained by Dr. Woolnough and Mr. J. L. Somerville, B.Sc., from a spot about three miles north of Mingenew Railway Station and at a height of about 125 feet above the station which is 502 feet above sea level. The collection is largely due to the enthusiasm of Mr. G. Wells, a local resident, through whom the specimens were obtained. They were found in a ferruginous sandstone lying almost horizontally and little is known about the stratigraphical relations. There are at least 70 feet of sandstone below the plant-bearing bed. In association with these sandstones there are marine beds of Jurassic Age, but there is doubt as to whether the marine beds are below or above the plant-bearing sandstones.

For the available information regarding the field occurrence I am indebted to Dr. Woolnough and Mr. Somerville, and I would express my thanks especially to Dr. Woolnough for the opportunity of examining the collection.

Three species of *Otozamites* have been recognised, viz.:— *O. Bechei*, *O. Feistmanteli* and *O. bengalensis*. In addition there are also coniferous fragments (? *Pagiophyllum* sp. and ? *Elatocladus* sp.), a doubtful cone, and indeterminate fragments of fossil wood.

OTOZAMITES BECHEI Brongniart. (Pl. x., figs. 3, 4).

1825 *Filicites Bechii*, Brongniart, Ann. Sci. Nat., iv., Pl. xix., fig. 4—1834 *Otopteris obtusa*, Lindley and Hutton, The Fossil Flora of Great Britain, Pl. cxxviii.—1849 *Otozamites obtusus*, Brongniart, Tableau, p. 104.—1900 *Otozamites obtusus*, var. *ooliticus*, Seward, The Jurassic Flora (Cat. Brit. Mus.), p. 218, Pl. i., fig. 1; Pl. ii., fig. 2.—1917 *Otozamites obtusus*, Walkom, Q'land. Geol. Surv., Pub. 259, p. 21, Pl. 8, fig. 1.

This specific name is used broadly to include numerous Cycadean fronds which have generally been described as *Otozamites obtusus*, which name, as Seward (1917, p. 540) has pointed out, must give way to *O. Bechei*.

"Frond pinnate; pinnae usually more or less falcate, occasionally straight and with parallel sides, attached obliquely to the upper side of the rachis; imbricate or separate, the upper edge of the base of the lamina strongly auriculate, the lower edge rounded; apex obtuse; veins strongly divergent especially in the lobed base and extending obliquely to the upper and lower edge of the lamina."

The specimens under examination agree well with the description and figures of this species. The fronds are about 4.5 cm. wide, with pinnae 2.5 cm. long and 7—8mm. wide. The pinnae in general make an angle of 65—70° with the rachis. The fronds are elongate lanceolate and would appear to be at least 20 cm. in length. The veins are divergent and numerous; there are about 12 at the base of the pinna, while further out, after they divide, there are about 15 in a breadth of 5 mm.

The same species has been described from Beaudesert, in Queensland (Walkom, 1917, p. 21).

OTOZAMITES FEISTMANTELI Zigno. (Pl. x., fig. 7).

1881 *Otozamites Feistmanteli*, Zigno, Flora Foss. Oolit., Vol. 2, p. 90, t. 34, f. 6—8.—1883 *Otozamites Mandesloki*, Tenison-Woods, Proc. Linn. Soc. N.S.W., viii., p. 151.—1890 *Otozamites Mandelslohi*, Feistmantel, Mem. Geol. Surv. N.S.W., Pal. 3, p. 147, t. 28, f. 9, 9a.—1892 *Otozamites Mandelslohi*, Etheridge Jr., Geol. Pal. Q'land., p. 381.—1910 *Otozamites Feistmanteli*, Arber, Geol. Surv. W.A., Bull. 36, p. 25.—1917 *Otozamites Feistmanteli*, Walkom, Q'land. Geol. Surv., Pub. 259, p. 23, t. 8, f. 2, 3.

"Frond narrow, linear; pinnae short and broad, attached to the upper face of the rachis by a broad base, of which the upper corner is slightly auriculate; the apex is bluntly rounded, the tip being directed upwards. Venation of the *Otozamites* type." (Seward, 1900, p. 221).

The fronds in the Western Australian specimens are about 3 cm. wide, but as all are incomplete it is not possible to determine the length. The pinnae are up to 1.7 cm. long and 7—8 mm. wide, with a rounded end. Their upper margins have a broad lobe near the rachis, the lower margins being straight. There are about 3 veins per mm.

The specimen from Talgai, Queensland, referred by Feistmantel (1890, p. 147) to *O. Mandelslohi* (Kurr) should be placed in this species.

This species is smaller and narrower than *O. Bechei*. Apart from the size and general shape there is not a great deal of difference between the fronds referred to these two species. But they are fairly distinct and, though numerous specimens are available, there is an absence of examples intermediate between the two.

OTOZAMITES BENGALENSIS Oldham and Morris. (Plate x., figs. 1, 2, 6).

1863 *Palaeozamia Bengalensis*, Oldham and Morris, Mem. Geol. Surv. Ind. (Pal. Ind.), Ser. ii., Vol. 1, Pt. 1, p. 27, Pl. xix., figs. 1, 2, 6.

This species was originally described and figured by Oldham and Morris from the lowest beds of the Rajmahal Group in India.

The frond is long and narrow, with short, relatively broad pinnae. In the Western Australian specimens the narrow linear fronds are up to about 1.8 cm. wide, but their length is indeterminate; one specimen, 9 cm. in length, is 1.8 cm. wide at its upper end and only narrows to 1.6 cm. wide at its lower end. The pinnae are up to 1 cm. in length and 5 or 6 mm. in width; they are obtusely rounded, but nearer the base of the frond become somewhat more acute. From above, the rachis is practically hidden. The veins are divergent and branch dichotomously; at the base of the pinna there are usually 6—10 veins, and further out they are more numerous, there being 4 to 5 per mm. The upper margin of the pinna has an obtuse lobe near the base; the lower margin is not lobed and is overlapped to about half its length by the upper margin of the next lower pinna.

Comparison of the specimens with the original figures of Oldham and Morris leaves little doubt of their identity. The species has not previously been described or recorded from Australia, but I have seen specimens from near Durikai, some thirty miles south-west from Warwick, Q., which I believe are identical.

It is possible that the specimens described as *O.* cf. *Mandelslohi* Kurr. from the Darling Downs, near Toowoomba, Q., (Walkom, 1917, p. 23), may belong to this species, though they differ somewhat in general appearance, having rather broader, more orbicular pinnae.

The specimens described above are from a locality some miles distant from that in which the specimens described by Arber (1910) were obtained. It is not possible to tell from Arber's published notes whether any specimens with the dimensions of *O. bengalensis* were amongst the collection submitted to him. It does not seem likely, however, that he would have included specimens with such narrow, elongate, linear form with *O. Feistmanteli*.

Loc.—About 3 miles north of Mingenew, W.A.

? Elatocladus sp.

A small fragment on specimen F12473 shows the basal portions of a number of pinnae attached to a rachis; the pinnae are about 2 mm. wide at the base and have a well-defined midrib in the portion visible. The specimen may be tentatively referred to *Elatocladus.*

? Cone.

A fragment, about 2 cm. long, of what may have been a cone, shows a number of spherical bodies, each about 3 mm. in diameter, attached to an axis. There are five of these bodies on each side of the axis, but it is impossible to give any details of their structure or of their arrangement on the axis. The specimen is F12473 in the Geological Survey Collection.

Coniferous fragments. (Pl. x., fig. 5).

Associated with the *Otozamites* there are obscure fragments of what appear to be coniferous branches. They show no detail of structure; the outline of one is figured, but no attempt is made to attach a definite name to them. Possibly they are what Arber (1910, p. 27) compared with *Pagiophyllum* sp.

There are also some fragments of fossil wood, but they apparently have no traces of structure preserved and it is impossible to make any use of them.

The Occurrence of Otozamites in Australia.

The genus *Otozamites* attains its widest geographical distribution in rocks of Jurassic age, but also occurs fairly abundantly in both Triassic and Lower Cretaceous Formations. In Australia, up to the present, it has only been found in rocks of Jurassic age and its geographic range in this region appears to have been limited. Rocks of Jurassic age are known in all the States and also in New Zealand, but so far, *Otozamites* has been recorded only from Queensland and Western Australia. Since, however, the Jurassic rocks in northern New South Wales (Clarence Series) are directly connected with those of southern Queensland in which this fossil occurs, future collecting may be expected to reveal the occurrence of *Otozamites* in New South Wales.

In the Jurassic Rocks of Victoria, Tasmania, and New Zealand, which are considerably further south than those already referred to, *Otozamites* does not appear to be present. It may be that the climatic conditions were not suitable for the growth of this plant, since there does not appear to have been any other formidable barrier to prevent it spreading to the south. But just as the Cycads of to-day do not extend into Victoria or Tasmania, so may those of Mesozoic times have been restricted to a like extent.

In Queensland, species of *Otozamites* have been found at widely-scattered localities in the south-east, viz.:—Thane's Creek and Durikai (both to the south-west of Warwick), Talgai, Darling Downs near Toowoomba, Kalbar (formerly Engelsburg), Beaudesert, and near Esk. At all of these localities, with the exception of Esk, the species are of similar general characters to those found in Western Australia, the records being: *O. Bechei* from Beaudesert, *O. Feistmanteli* from Thane's Creek, Talgai and Kalbar, *O.* cf. *Mandelslohi* from Darling Downs near Toowoomba, and *O. bengalensis* from Durikai.

The specimens described from Esk (Walkom, 1917, p. 21) are quite distinct from any of the above and some doubt has been expressed as to whether

they are rightly referred to the genus. Dr. Stopes (1918, p. 230) differs from my determination of them as *Otozamites,* but does not suggest to what genus she considers they should be referred.

The rocks in which these species occur are all referred to the Walloon Series or its equivalents, which are of undoubted Jurassic age.

The Western Australian occurrences of *Otozamites* are confined, so far as is known, to the neighbourhood of Mingenew, and Madinganarra, to the north of Derby. The only published records are those of Arber (1910), about three miles south of Mingenew, and A. Gibb Maitland (1919, p. 41) near Derby, in addition to those described in the present paper from about three miles north of Mingenew. The species comprise *O. Bechei, O. Feistmanteli* and *O. bengalensis* from the neighbourhood of Mingenew, and *O.* sp. from Madinganarra.

Mr. A. Gibb Maitland, in his Summary of the Geology of Western Australia (1919, p. 41), records the occurrence of the genus in the north-west of Australia thus:—

"Dr. H. Basedow obtained in 1916 several impressions of Mesozoic ferns in a yellowish argillaceous sandstone or grit met with in a well at Madinganarra, near Point Torment, to the north of Derby in King Sound in the Kimberley Division. The specimens have been determined by the late Mr. R. Etheridge, Jun., as *Otozamites,* together with stem impressions of either *Phyllotheca, Equisetites,* or *Schizoneura.* The evidence of these plant remains would seem to indicate a Jurassic age for the beds and a horizon equivalent to that of the beds in the vicinity of Mingenew."

Further confirmation of the presence of Jurassic rocks in the neighbourhood of Derby is afforded by the occurrence of fossil plants which have been described by Antevs (1913). These include *Thinnfeldia Feistmanteli* from Mayils Well, near Derby, occurring in a light gray clay at a depth of 300 feet, and *Ptilophyllum* ? sp. from Point Torment, 32 miles from Derby, in a soft, coarse, reddish sandstone at a depth of 30 feet.

The examination of the specimens, described above, from Mingenew shows a very remarkable lithological similarity between the Jurassic sandstones in which the fossils occur in Western Australia and Queensland. This is a dark-red, ferruginous sandstone and, if collections from the two States were mixed, it would indeed be difficult to separate the Queensland from the Western Australian specimens. There is also an indication of the occurrence of a similar type of rock containing *Ptilophyllum* in the Derby district in Antevs' description of fossil plants from that area, quoted above.

Attention has previously been called to the widespread development of this rock in Queensland and to the probability of it indicating a well-marked horizon in the Walloon Series (Walkom, 1918, p. 50). Possibly it is the result of some special climatic conditions and it gives indication of the synchronous deposition of the strata over a comparatively wide area. It should certainly prove a very valuable horizon when more detailed stratigraphical work is done on the Jurassic strata of Australia.

In writing on the subject of Geologic Climates, F. H. Knowlton refers to the subject of Red Beds (1919, p. 506) and his remarks may be quoted here as having some bearing on the indications afforded by this widespread development of a red sandstone in regard to the climatic conditions of the period during which it was deposited. He says:—"At this point I may stop for a moment to consider the deductions to be drawn from the presence of red beds. Most geologists interpret the presence of red beds as an indication of aridity.

On the contrary, it seems to me that the evidence is fairly conclusive that red beds may have been formed under conditions of warm, moist climates. Briefly, the reasons for this view are as follows: (1) So far as known, red beds are not being formed at the present time in any desert region, but as maturely weathered residual soils they are being formed in southern temperate and tropical regions, and in warm, moist climates. (2) The plants found in red beds, as, for example, in the Permian, Triassic, etcetera, are not pinched or depauperate, nor do they exhibit marked xerophytic adaptations. Moreover, very considerable deposits of coal are found in red beds in many parts of the world, which implies the presence of swamps but little above sea level."

It is not argued here that the Australian beds under discussion are typical "red beds," but it may be pointed out that the term is somewhat loosely used, and the prevailing colour of these beds might lead to their being quoted as examples of red beds by writers not acquainted with them in the field or by specimens.

These remarks are very much strengthened, in my opinion, when we take into consideration the known flora of this particular sandstone in Australia. Though somewhat scanty, a flora consisting essentially of *Osmundites*, *Taeniopteris* and *Otozamites*, could not be considered to indicate the existence of arid conditions where it flourished.

It may therefore be argued that the very widespread occurrence of this red sandstone with its persistent and characteristic, though scanty, flora probably indicates a fairly uniform, warm, moist climate over the northern half of Australia in Jurassic times. What climatic significance the absence of *Otozamites* from the Jurassic Rocks of Southern Australia has is not yet clear, for *Taeniopteris* occurs abundantly in Victorian Jurassic rocks, and both *Osmundites* and *Taeniopteris* occur in New Zealand.

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EXPLANATION OF PLATE X.

The specimens figured on this plate have been presented to the Geological Survey of New South Wales, their registered numbers being 12469–12472 inclusive.

1. *Otozamites bengalensis* Oldham and Morris. View of upper surface of frond. (F12469). Nat. size.
2. *Otozamites bengalensis* Oldham and Morris. Pinna enlarged (x3) showing venation.
3. *Otozamites Bechei* Brongniart. View of upper surface of frond. (F 12470). Nat size.
4. *Otozamites Bechei* Brongniart. Pinna enlarged (x2) showing venation.
5. Coniferous branch (*? Pagiophyllum* sp.) (F 12471). Nat. size.
6. *Otozamites bengalensis* Oldham and Morris. View of impression of lower surface of frond, with the rachis removed. (F 12472). Nat size.
7. *Otozamites Feistmanteli* Zigno. Drawing of portion of frond. (F 12471). Nat. size.

NOTE UPON THE EXTRACTION OF ACIDS FROM CULTURES.

By R. Greig-Smith, D.Sc., Macleay Bacteriologist to the Society.

In testing the products of the fermentation of dextrose by a film yeast, succinic acid was obtained as the only fixed acid, but during its separation, several observations were made which may be of interest.

The fermented fluids are usually evaporated *in neutral or alkaline solution*, generally in the presence of an excess of calcium carbonate and when the liquid is sufficiently reduced, it is cooled and the lime salts decomposed with sulphuric acid, after which the calcium sulphate is removed by filtration and the volatile acids removed in a current of steam.

The residual fixed acids are then evaporated until of sufficient consistency to be extracted with ether. There may be, and usually is, a quantity of sugar in the liquid which prevents the evaporation being pushed to a limit, say, of 20 c.c. or which does not give a tractable dry powder when mixed with sand. In such cases one has to work with a volume of liquid measuring possibly 100 c.c. With this volume, the extraction is slower than is generally considered. For example, Schoorl (through Journ. Soc. Chem. Ind., xix., 1900, 567), when working with pure acids, found that succinic, lactic and oxalic acids were extracted from 20 c.c. of liquid in 8 hours. The time may be longer in the presence of much sugar and nitrogenous substances, but this has not been investigated. Schoorl states that the time of extraction depends upon the partition equivalent, which is the $\frac{\text{solubility of the acid in water.}}{\text{solubility of the acid in ether.}}$ An acid such as succinic with a low coefficient takes a short time, and one with a high coefficient such as tartaric acid takes a long time. He gives the coefficients as succinic, 4; oxalic, 8; lactic, infinity; malic, 24; citric, 59; and tartaric, 330. In extracting unknown acids as, for example, in a bacterial culture, one naturally continues the extractions until little or no residue is obtained upon evaporating the ether from a three hours' extraction.

More recently Pinnow (Jour. Soc. Chem. Ind., xxxv., 1916, 197) determined the coefficients of distribution between certain organic acids in water and in ether and compared the speed of their extraction by ether in a Parthiel-Rose extraction apparatus. He found that the extraction practically followed the formula for monomolecular reactions and, within certain limits, was inversely proportional to the volume of liquid extracted and to the distribution coefficient. His coefficients at 27° are for succinic acid, 7.58; lactic, 11.28; oxalic, 13.9;

malic, 70.9; and citric, 153. The time in minutes required for a 99 % extraction in a Parthiel-Rose apparatus holding 30 c.c. is obtained by dividing the Distribution Equivalent by 0.04.

From this one gathers that lactic acid is extracted in 4¾ hours in a Parthiel-Rose apparatus holding 30 c.c., while in a Schoorl apparatus it took 8 hours dealing with 20 c.c. The kind of apparatus is therefore of some moment. The Schoorl apparatus can easily be obtained and is the one I have used. A test with it upon 100 c.c. of liquid containing 0.25 grams of succinic acid showed that 79 % was extracted in 7 hours and 99 % in 12 hours. The presence of 5 % of dextrose made no difference in the speed of extraction.

The fixed acids from the film yeast were contained in a fairly strong solution of sugar with ammonium and other salts and measured about 100 c.c. After certain periods of extraction the bulk of the ether was distilled off, the remainder air-evaporated and the residue titrated with tenth-normal soda.

Period of extraction	Acid extracted as c.c. of tenth normal.		
7 hours	48.4		or 53 %
19 hours	23.3	71.7	78 %
31 hours	9.3	81.0	86 %
43 hours	5.5	86.5	94 %
55 hours	5.3	91.8	100 %

In another test the acids had been extracted and the calcium salts, insoluble in 70 % alcohol, were treated with sulphuric acid and percolated with ether. The volume measured 50 c.c.

Period of extraction	Acid extracted as c.c. of tenth normal.		
7 hours	81.83		or 61 %
19 hours	29.95	111.78	83 %
31 hours	15.05	126.83	95 %
43 hours	6.93	133.76	100 %

Curves prepared from these figures showed that they were of the nature of monomolecular reactions, while an extended examination of the portions showed that succinic acid was the only acid present. The examination was extended because succinic acid is not so definite in its behaviour as one is led to suppose. The slight solubility of the calcium and of the silver salts causes it to appear in places where other acids are expected. For example, while a pure salt of succinic acid was completely precipitated by silver nitrate and contained the theoretical amount of silver, the neutral salt of the acid obtained from the yeast culture was not completely precipitated, for the quantity was lower than was expected from the neutralisation numbers and the filtrate contained a considerable amount of the acid. So much so that it almost appeared as if there were more than one kind of succinic acid. The melting point was normal while the silver content of the silver salt was low, 62.4 and 62.6, as against the theoretical 65.07 %. There was always a small quantity of a syrupy substance associated with the acid. It was too small in amount to determine its nature, but it influenced the crystallisation of the pure acid. It is possible that it may have had something to do with the solubility of the silver salt.

An attempt was made to determine the nature of this syrupy acid. The mother-liquor, after the 55 hours' extraction (see above) was treated with an

excess of baryta, and evaporated to small volume, with the idea of hydrolysing any acid esters. The liquid was treated with sulphuric acid and extracted for 12 hours with ether. The residual acids were neutralised with 9.15 c.c. of N/10 baryta water and were treated with sufficient alcohol to make a 75 % solution. The precipitated barium succinate was filtered off and dried at 130° when it gave 0.0416 gram which contained 54.76 % Ba. Barium succinate contains 54.16 %. The filtrate, when evaporated and dried at 130°, gave 0.1038 gram containing 33.33 % Ba. The barium succinate corresponded to 3.29 c.c. N/10, which left 5.86 c.c. for the acid in the alcohol-soluble salt. Deducting the Ba. and allowing for the H_2 equivalent, the acid was calculated as weighing 0.0697 gram. This gave a neutralisation equivalent of 119 and, as we have seen, the Ba. content was 33.33 %. Isovaleric or levulinic acid is indicated, but the quantity worked upon was very small for absolutely definite identification.

As a matter of fact, the substance was probably lactic acid, for in working through another culture, the succinic acid was precipitated as the barium salt in 75 % alcohol and the filtrate, after evaporation, acidification and extraction with ether, yielded a syrupy residue which, when boiled with zinc oxide, furnished crystals of zinc lactate.

One has to be very careful in deducing the nature of the acid from small quantities of material as, even with comparatively large quantities, one may be led into error. For example, a culture of the same yeast was made with dextrose, ammonium nitrate, and sodium phosphate in the presence of chalk. In working up the products, the ethereal solution was evaporated in the air and then distilled in a current of steam. On concentrating the solution on the water bath a disengagement of nitric oxide occurred. The nitric acid had formed nitrous ether during a part of the process, and this had not been removed by the steam and had decomposed on warming in the open. The residual acids were neutralised with baryta water in the presence of phenolphthalein to a permanent pink colour, when a precipitate of barium phosphate and oxalate was thrown down. The filtrate on concentration threw down successive crops of a crystalline precipitate containing 47.8 % and 48.9 % of Barium. A portion of the precipitate acidified and extracted with ether yielded crystals of succinic acid melting at 183°. The mother liquor now required a considerable quantity of baryta water to give it a permanent pink tint. Thus the original addition of baryta to the first solution sufficient to give a permanent pink colour was not sufficient to produce normal barium salts, for if so the amount of Barium in the precipitated succinate would have been nearer the theoretical 54.16 % and the further addition of baryta to the mother liquor would have been unnecessary.

Summary.—The extraction of the fixed acids from bacterial or from yeast cultures is, as has been shown by other writers, of the nature of a monomolecular reaction and should be continued until no more acid is extracted.

The preparation of salts, such as those of barium, by neutralising the extracted acids until a pink colour is obtained in the presence of phenolphthalein, may be faulty as the reaction is much slower than is generally supposed.

ORDINARY MONTHLY MEETING.

27th April, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Miss Eleanor E. Chase, B.Sc., "Tavua", Macintosh Street, Gordon, Messrs. Alan P. Dodd, Gordonvale, via Cairns, Q., John A. Kennedy, M.B., Ch.M., Dulwich Hill, and Ellis Le G. Troughton, Australian Museum, Sydney, were elected Ordinary Members of the Society.

The President offered the congratulations of members to Professor J. P. Hill (in absentia) on his appointment to the Chair of Embryology at University College, London, and to Professor T. T. Flynn on his attaining the Doctorate of Science of the University of Sydney.

An appeal was read from the Mikrographische Gesellschaft, Vienna, for funds to carry on its laboratory.

The Secretary exhibited a photograph of the garden of Linnaeus at Upsala, presented to the Society by Colonel Roth.

The Donations and Exchanges received since the previous monthly meeting (30th March, 1921), amounting to 19 Vols., 418 Parts or Nos., 1 Bulletin, 1 Report and 1 Pamphlet, received from 45 Societies and Institutions and three private donors, were laid upon the table.

NOTES AND EXHIBITS.

Mr. Fred. Turner exhibited and offered observations on the following plants:—(1) *Myosurus minimus* Linn., found near Bourke, November, 1920. He had not previously seen this plant growing west of the Darling River, consequently it was not included in his botanical survey of that part of New South Wales (These Proceedings, 1903). (2) He called attention to the finding of a plant of *Tecoma Hillii* F.v.M. on Fraser Is. by Mr. W. R. Petrie, a Queensland Forestry Officer. This plant had been exhibited at a meeting of this Society in 1903 by Mr. Turner who had discovered it at Hervey Bay in 1876. (3) *Eryngium rostratum* Cav., a specimen of which the exhibitor had received for determination from Mr. R. Baird, Multagoona, Darling River. Mr. Baird had written "that this plant was eaten ravenously by all classes of stock, even when other good pasture feed was abundant.

Mr. R. T. Baker exhibited herbarium specimens and timber of a new species of *Eucalyptus* from Hill Top, known locally as "Blue Stringy Bark." A full description of the species and its economics will be submitted to the Society at an early date.

Mr. W. F. Blakely exhibited from the National Herbarium four weeds not hitherto recorded for the State. (1) *Calandrinia caulescens* H.B. et K. var. *Menziesii* Gray, a native of California and British Columbia, from Tipperary, near Young (R. Nixon, Sept., 1913), Hawkesbury Agricultural College, "Introduced with American hay" (C. T. Musson, Oct., 1917), Deniliquin (W. C. Wentworth, Oct., 1920) and Canoblas, "It produces small shiny black seeds in such quantity as to cover the ground under the plants. Stock eat it and at the stage when it is well ripe they seem to eat up the seeds as well". (W. C. Clark, Oct., 1920). (2) *Sisymbrium altissimum* L., "Tumbling Mustard;" a tall twiggy plant belonging to Cruciferae, from Cudal. When mature, the stems break off near the surface of the ground, and the plants are tumbled about by the wind, hence the vernacular name. The first botanical record of this plant is from the northern shores of the Mediterranean Sea, but it is now common throughout Europe, Northern Africa, Western Asia, the United States of America and Canada. In these countries it is a very troublesome agricultural weed, and every effort is being made to eradicate it. (3) *Orthocarpus purpurascens* Benth. (4) *O. erianthus* Benth., family Scrophulariaceae. Both plants are indigenous to California. They were first brought under notice by Mr. C. T. Musson, of the Hawkesbury Agricultural College, in 1916, having come up in the vicinity where stock had been fed on American hay. The former has been collected from the same locality by Mr. W. M. Carne this year, and also from Trangie Experiment Farm (C. A. Linden.).

Miss S. Hynes exhibited a specimen of *Monstera deliciosa* Liebm., N.O., Araceae, a native of Tropical America, with perforated leaves (c.f. *Aponogeton fenestralis,* the Madagascar lace leaf plant, an aquatic plant). The spadices are edible when ripe, and the plant can be grown near Sydney.

Mr. A. R. McCulloch gave a short account of Lord Howe I., illustrated by lantern views.

REVISION OF AUSTRALIAN LEPIDOPTERA*—*HYPSIDAE, ANTHELIDAE.*

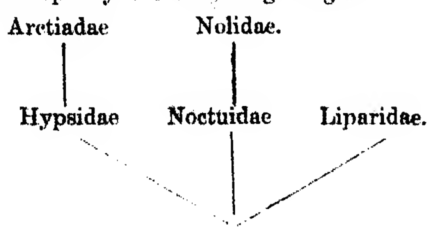
By A. Jefferis Turner, M.D., F.E.S.

Fam. HYPSIDAE.

Tongue present. Head, thorax, abdomen, and femora smooth. Forewings with 1 absent, areole present, 8 and 9 stalked from areole, 5 approximated to 4 at origin. Hindwings with frenulum present, 1 absent, discocellulars angled, 5 arising from below angle and approximated to 4, 6 and 7 usually stalked, 8 approximated and connected with cell before middle, or shortly anastomosing with cell at $\frac{1}{3}$ or $\frac{1}{4}$.

A small family, represented in Australia by fourteen species, all of which have been well described by Mr. Meyrick, but there has been some confusion in the synonymy, and some of the names adopted by him must be altered. I formerly substituted *Asota* Hb. for the long-recognised *Hypsa* Hb., on the ground that the former name occurs first in his Verzeichniss, but I now consider that this change was unnecessary, and that it would be better to regard *Hypsa* as a *nomen conservandum.*

Undoubtedly the *Hypsidae* are allied to the *Liparidae,* the presence of a tongue and the general smooth scaling being the only definite distinctions, but it is impossible to merge the two groups unless we are prepared for much larger amalgamations. In some genera, such as *Nyctemera* and the European *Callimorpha,* there is a short anastomosis of the hindwing subcostal with the cell rather near its base (about $\frac{1}{4}$), and this brings the family into very close relationship to the *Arctiadae,* which I have no doubt is a direct derivative. It might, indeed, be a more natural arrangement to restrict the *Hypsidae* to those genera in which the hindwing subcostal does not anastomose, and to remove *Callimorpha, Nyctemera* and *Argina* to the *Arctiadae.* It is difficult, if not impossible, to separate the *Noctuidae* from the *Arctiadae* by any definite character, but if the *Nolidae* are, as Hampson suggests, descended from the *Sarrothripinae* section of the *Noctuidae,* they must be regarded as a distinct family approximated to the *Arctiadae* by convergence. We may illustrate our conception of these relationships by the following diagram:—



Although the Australian genera of this family all retain the primitive areole, it is possible that exotic genera exist, in which it has been lost.

*Continued from These Proceedings, vol. xlv., 1920 (1921), p. 499.

1. Hindwings with 8 anastomosing with cell at about ¼ 2
   Hindwings with 8 approximated only, or connected 4
2. Palpi porrect 3
   Palpi ascending, reaching vertex .. .. *Argina*
3. Forewings with 10 connate with 8, 9 from areole .. .. *Exitelica*
   Forewings with 10 arising separately from areole .. .. *Nyctemera*
4. Hindwings with 3 and 4 connate, 5 well separate .. .. *Digama*
   Hindwings with 3, 4, 5 approximated 5
5. ♂ without costal retinaculum, palpi with terminal joint about ½ second .. .. *Agape*
   ♂ with costal retinaculum, palpi with terminal joint about as long as second .. .. *Hypsa*

Gen. 1. EXITELICA,* nov.

Palpi moderate, porrect; basal joint long, rough-scaled beneath; second and terminal joints short, smooth. Antennae of ♂ very shortly bipectinate, towards apex simple; of ♀ simple. Forewings with areole narrow, 10 connate with 7, 8, 9, which are stalked. Hindwings with 3, 4, 5 well separate at origin, 6 and 7 connate or stalked, 8 anastomosing shortly with cell at about ¼, cell about ⅔.

Beside the neuration of the forewings this differs from *Nyctemera* in the shorter palpi and different antennae.

1. EXITELICA AEGROTA.

Nyctemera separata Meyr., Proc. Linn. Soc. N. S.Wales, 1886, p. 762, *nec* Wlk. *Leptosoma aegrotum* Swin., Cat. Oxf. Mus., i., p. 145, Pl. v., f. 15 (1892). *Nyctemera mackieana* Luc., Proc. Roy. Soc. Q'land, 1898, p. 60.

N. Q'land: Cape York, Claudie River, Cooktown, Cairns, Innisfail, Ingham, Atherton, Mackay.

Gen. 2. NYCTEMERA.

Nyctemera Hb., Verz., p. 178.

Palpi rather long, porrect, smooth, but basal joint hairy, terminal joint rather long (½). Antennae in ♂ with long double pectinations, apex sometimes simple; in ♀ also bipectinate. Forewings with 10 arising from areole well separate from 8, 9; 7 connate or separate. Hindwings with 3, 4, 5 well separated at origin, 6 and 7 connate or stalked, 8 anastomosing shortly with cell at about ¼, cell ⅔ to ¾.

Type, *N. lactinia* Cram. from the Archipelago and India.

1. Both wings with cilia whitish-ochreous .. .. *amica*
   Both wings with cilia wholly fuscous 2
2. Forewings with fascia undivided .. .. *drucei*
   Forewings with fascia divided by fuscous veins 3
3. Hindwings white except terminal band .. .. *baulus*
   Hindwings fuscous with central white blotch .. .. *secundiana*

2. NYCTEMERA AMICA.

Agagles amica White, Grey's Discoveries in Australia, ii., Appendix., p. 482.—*Nyctemera amica* Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 760.—*Nyctemera plagiata* Gn., Ent. Mo. Mag., 1868, p. 2.

* ἐξιτηλικος, faded.

Q'land.: Eidsvold, Gympie, Nambour, Brisbane, Toowoomba, Nanango, Cunnamulla, Stanthorpe; N.S. Wales: Glen Innes, Newcastle, Sydney; Vic.: Melbourne, Gisborne; Tas.: Hobart, Triabunna; S. Aust.: Mt. Lofty; W. Aust.: Yallingup.

3. NYCTEMERA DRUCEI.

Nyctemera crescens Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 761, *nec* Wlk.—*Deilemera drucei* Swin., Trans. Ent. Soc., 1903, p. 73.— *D. dinawa* B.-Bak., Nov. Zool., 1904, p. 411, Pl. 6, fig. 37.

N. Q'land.: Cooktown, Cairns, Herberton. Also from New Guinea.

4. NYCTEMERA BAULUS.

Leptosoma baulus Bdv., Voy. Astrol., Lep., p. 200 (1832). *Nyctemera mundipicta* Wlk., Jour. Linn. Soc., Zool., 1859, p. 184. *N. fasciata* Wlk., Cat. Brit. Mus., vii., p. 1665. *N. integra* Wlk., *ib.*, xxxv., p. 1879. *N. tertiana* Meyr., Ent. Mo. Mag., xxiii., p. 15; Proc. Linn. Soc. N.S. Wales, 1886, p. 761.

N. Q'land.: Thursday Is., Cairns, Atherton, Herberton.

Also from New Caledonia, New Hebrides, Fiji, and the Malayan Archipelago.

5. NYCTEMERA SECUNDIANA.

Nyctemera secundiana Luc., Proc. Linn. Soc. N.S. Wales, 1891, p. 280.

It is still uncertain whether this is anything more than a form of the preceding, as Meyrick believed.

N. Q'land.: Cairns, Ingham, Herberton; Q'land.: Rockhampton, Brisbane, Mt. Tambourine, National Park (3000 ft.), Toowoomba.

Gen. 3. ARGINA.

Argina Hb., Verz., p. 167.

Palpi rather long, ascending, in ♂ appressed to frons, in ♀ more oblique, slightly roughened anteriorly; terminal joint moderate. Antennae of ♂ bidentate, towards apex simple; of ♀ simple. Forewings with areole rather narrow, 7, 8, 9 stalked from areole, 10 connate with them. Hindwings in ♂ produced to a sharp tooth at tornus; cell long ($\frac{2}{3}$), 3, 4, 5 separate, 6 and 7 connate or short-stalked, 8 anastomosing shortly with cell at about $\frac{1}{4}$.

Type, *A. cribraria* Clerck.

6. ARGINA CRIBRARIA.

Phalaena cribraria Clerck, Icon. Ins., ii., Pl. 54, f. 4. *Nyctemera cribraria* Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 763.

N. Aust.: Melville Island; N. Q'land.: Thursday Island, Cape York, Cooktown, Innisfail, Ingham, Dunk Island, Atherton, Herberton, Townsville; Q'land.: Duaringa, Brisbane.

Also from New Guinea, China, Ceylon, India, Africa, and Madagascar

Gen. 4. DIGAMA.

Digama Moore, Lep. E. I. Co., p. 297.

Palpi long, ascending, appressed to frons, smooth; terminal joint long ($\frac{2}{3}$). Antennae of ♂ sometimes bipectinate, towards apex simple; of ♀ simple. Fore-

wings with 4 and 5 approximated at origin, 8 and 9 stalked from areole, 7 connate or approximated, 10 widely separate. Hindwings with 3 and 4 connate, 5 separate, 6 and 7 connate, 8 closely approximated to cell from ¼ to middle, not connected.

Type, *D. hearseyana* Moore, from India.

7. Digama marmorea.

Digama marmorea Butl., Trans. Ent. Soc., 1877, p. 363; Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 772. *D. piepersiana* Snel., Tijd. v. Ent., 1879, p. 81, Pl. 7, f. 2.

N. Aust.: Roebuck Bay, Daly River; N. Q'land.: Cairns, Innisfail, Atherton; Q'land.: Duaringa, Gayndah, Brisbane, Helidon, Toowoomba, Dalby.

Also from New Hebrides and Celebes.

Gen. 5. Agape.

Agape Snel., Tijd. v. Ent., 1888, p. 115; Jordan, Nov. Zool., 1896, p. 60.

Palpi long, ascending, appressed to frons, smooth; terminal joint ½. Antennae in ♂ simple, ciliated. Forewing in ♂ without subcostal retinaculum; 8 and 9 stalked from areole, 7 connate or separate, 10 separate. Hindwings with 3, 4, 5 approximated, 6 and 7 connate, 8 approximated and connected with cell at ¼.

Type, *A. chloropyga* Wlk.

8. Agape chloropyga.

Hypsa chloropyga Wlk., Cat. Brit. Mus., ii., p. 455; Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 771.—*H. analis* Wlk., *ib.*, vii., p. 1677.— *Agape cyanopyga* Feld., Reise Nov., Pl. 106, f. 4.

N. Q'land.: Cape York, Cooktown, Atherton, Herberton, Townsville, Bowen; Q'land.: Brisbane; N.S. Wales: Port Macquarie.

Also from Ceram and Amboyna.

Gen. 6. Hypsa.

Hypsa Hb., Verz., p. 172.

Palpi very long, ascending, appressed to frons, smooth; terminal joint as long, or nearly as long, as second joint. Antennae in ♂ with cilia and bristles, the latter often very long. Forewings with 8 and 9 stalked from areole, 7 separate, 10 widely separate. Hindwings with 3, 4, 5 separate, 6 and 7 usually approximated, 8 approximated and connected with cell at ¼.

Type, *H. monycha* Cram., from India.

1.	Hindwings white	2
	Hindwings orange-ochreous	3
2.	Forewings without central streak	*basilissa*
	Forewings with white central streak from base	*dama*
3.	Hindwings without dark spots	*orbona*
	Hindwings with dark spots	4
4.	Forewings with an irregularly dentate, whitish, antemedian fascia ..	*plagiata*
	Forewings without antemedian fascia	5
5.	Forewings with base whitish-ochreous	*iodamia*
	Forewings with base orange	*alciphron*

9. Hypsa basilissa.

Hypsa basilissa Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 767.

N. Aust.: Pt. Darwin, Melville Is.; N. Q'land.: Cooktown, Cairns.

10. HYPSA DAMA.

Noctua dama Fab., Spec. Ins., ii., p. 216. *Hypsa dama* Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 768.

N. Aust.: Pt. Darwin; N. Q'land.: Cape York, Cooktown, Cairns, Innisfail, Ingham, Dunk Is., Townsville.

Also from New Guinea.

11. HYPSA ORBONA.

Hypsa orbona Vollen., Tijd. v. Ent., vi., p. 137, Pl. ix., f. 4. (1863); Jord., Nov. Zool. 1897, p. 328.—*H. significans* Wlk., Cat. Brit. Mus., xxxi., p. 215, (1864).—*H. australis* Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 770, *nec.* Bdv.

N. Aust.: Pt. Darwin; N. Q'land.: Cooktown, Cairns, Mackay. Also from New Guinea.

12. HYPSA ALCIPHRON.

Phalaena alciphron Cram., Pap. Exot., ii., 1777, Pl. 133E.—*Noctua caricae* Fab., Ent. Syst., iii., 2, 1794, p. 27; Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 769.

N. Aust.: ——; N. Q'land.: Cape York, Cooktown, Innisfail, Townsville, Mackay.

Also from the Archipelago and India.

13. HYPSA PLAGIATA.

Hypsa plagiata Wlk., Cat. Brit. Mus., ii., 457; Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 768.—*H. discreta* Wlk., *ib.*, xxxi., p. 216.

N. Aust.: Darwin; N. Q'land.: Innisfail, Herberton, Townsville, Bowen; Q'land.: Rockhampton, Gympie, Brisbane, Southport, Nanango; N.S. Wales: Clarence River.

14. HYPSA IODAMIA.

Hypsa iodamia H-Sch., Auss. Schmet., f. 119.—*H. nesophora* Meyr., Proc. Linn. Soc. N.S. Wales, 1886, p. 770.

Q'land.: Brisbane, Coolangatta, Toowoomba; N.S. Wales: Newcastle, Sydney.

Mr. R. Illidge, who has bred large numbers of this and the preceding species from larvae on the Moreton Bay fig, has obtained intermediate forms. He could detect no differences in the larvae, and suggests that both forms are one species. This seems to me hardly possible; perhaps the intermediates are hybrids.

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INDEX TO SPECIES.
Synonyms in Italics.

Fam. ANTHELIDAE.

Tongue absent (except in *Munichryia*). Antennae pectinated to apex in both sexes. Head, thorax, abdomen, and femora hairy. Forewings with 1 absent, 5 approximated to 4 at origin, areole very long, 7, 8, 9, 10 all arising separately from areole (except that 7 and 8 are connate or stalked in *Aprosita*); a subapical cross-vein connects 9 and 10 soon after their separation, and may be prolonged towards or to 11. Hindwings with basal costal projection and well-marked humeral angle, frenulum well-developed in ♂, absent in ♀; 1 absent, 5 from below angle and approximated to 4, 11 present or absent, 12 widely separate or approximated to cell.*

This is a small family of about 50 species peculiar to the Australian region. At least one species is known from New Guinea, but the family is not recorded elsewhere. The genus *Anthela,* to which belong six-sevenths of the known species, is distributed fairly evenly throughout Australia, including both inland and coastal regions, from Cape York to Hobart, and from Brisbane to Perth. The internal classification of the family is simple. *Gephyroneura* and *Munichryia* are separable by the subapical crossbar extending to 11 in the forewing, and by 12 of the hindwing being approximated to the cell, so that 11 is short or replaced by an anastomosis. These two genera are very distinct from the rest and could be regarded as a subfamily. Of the remaining genera *Nataxa* and *Aprosita* are simple developments of *Anthela,* while *Pterolocera* and *Chelepteryx* are nearly related collaterally.

I have already (Trans. Ent. Soc., 1919, p. 415) given my reasons for separating this family from the *Liparidae.* They differ in the structure of the areole. Only in a very few genera of *Liparidae,* such as *Redoa,* is the areole very long, and then it is very narrow, and the branch veins from it do not arise separately. The subapical cross-bar is peculiar to the *Anthelidae,* and in view of the rarity of any new structural development in any family of *Lepidoptera,* it is of great importance. Present in all species, it is in some individuals represented only by a fold in the wing membrane. In abnormal examples of some species the cross-bar between 8 and 9 fails to develop, leaving the areole open; analogous abnormalities occur in other families. In the hindwing, 12 is usually widely separate from the cell; the comparative approximation in *Pterolocera* and *Chelepteryx* is merely secondary to a narrowing of the hindwings. Only in *Munichryia* and *Gephyroneura* does a true approximation or anastomosis occur, strictly comparable to that characteristic of the *Liparidae.* We can hardly suppose that the more archaic condition in the hindwings of *Anthela* is due to a reversion, and must therefore assume that the ancestor of the group, allied to *Munichryia* in the forewings, was nearer *Anthela* in the hindwings. The absolute want of any tendency to the approximation of the origins of 9 and 10 from the areole, which leads to the loss of that structure in many genera of the *Liparidae,* is remarkable. Certainly the antennae and absence of a tongue concur in both families, but the latter character breaks down in *Munichryia.* The only point left to connect the two families is the origin of vein 5 in both wings. From this we may conclude that, while there may be a real relationship between them, it must be remote. This conclusion is strengthened by the differences in the coupling-apparatus of the wings. The *Anthelidae* have a basal costal ex-

***Vein 1 is usually known as 1c. The subcostal in the hindwings I have hitherto called 8 according to usage. In the future I propose to call it 12. 11 is the first branch of the radial in both wings.**

pansion and a well-marked humeral angle; while the frenulum and subcostal retinaculum are well-developed in the ♂, but both frenulum and retinaculum are absent in the ♀.

1.	Forewings with subapical bar not reaching vein 11	2
	Forewings with subapical bar running from 11 to 9	6
2.	Posterior tibiae without middle spurs	3
	Posterior tibiae with middle spurs	*Ohelepteryx*
3.	Hindwings with 12 approximated to middle of cell, ♀ apterous ..	*Pterolocera*
	Hindwings with 12 well separated from cell, ♀ with wings fully developed	4
4.	Palpi almost obsolete	*Nataxa*
	Palpi normally developed	5
5.	Forewings with 7 and 8 connate or stalked from areole; or areole open	*Aprosita*
	Forewings with 7, 8, 9, 10 arising separately from areole	*Anthela*
6.	Tongue obsolete	*Gephyroneura*
	Tongue present	*Munichryia*

Gen. 1. PTEROLOCERA.

Pterolocera Wlk., Cat. Brit. Mus., iv., p. 884.

Palpi moderately long, porrect; second joint with very long hairs beneath; terminal joint long. Antennae of ♂ bipectinate to apex, pectinations very long. Posterior tibiae without middle spurs. Forewings with 4 and 5 separate, all veins from areole separate, subapical cross-bar from 10 to 9 beyond their bifurcation. Hindwings with 3, 4, 5 separate, 6 and 7 connate or approximated, 12 somewhat approximated to cell about middle, not connected.

♀ apterous with simple antennae and rudimentary tibial spurs.

1. PTEROLOCERA AMPLICORNIS.

Pterolocera amplicornis Wlk., Cat. Brit. Mus., iv., 1855, p. 884.—*P. insignis* H-Sch., Lep. Exot., 1858, f. 459.

♂. 35—54 mm. Head and thorax densely hairy; pale ochreous-brown, brown, or reddish-brown. Palpi 1½ to 2; brownish or fuscous. Antennae whitish or grey; pectinations fuscous. Abdomen brownish, reddish-brown, or pale ochreous-brown; in pale examples the dorsum of basal segments may be darker brown. Legs reddish-brown or brown; tarsi usually fuscous. Forewings broadly or narrowly triangular; costa straight or slightly sinuate, apex pointed, termen bowed, slightly oblique; pale ochreous-brown, brown, reddish-brown, or fuscous-brown; veins sometimes more or less outlined with fuscous; sometimes a faint postmedian fuscous line, or this may be represented by dots on veins; sometimes two, fuscous, antemedian dots in middle and above dorsum; cilia concolorous. Hindwings with termen only slightly rounded; as forewings. Underside similar.

Very variable both in shape and colour of forewings, with some tendency to form local races, but these again are variable. Western Australian examples are usually redder, and in some of them the dots on the forewings are exaggerated.

♀. Apterous; dark-fuscous; nearly smooth above, rather hairy beneath; antennae simple; tibial spurs rudimentary. A very un-moth-like insect.

Q'land.: Toowoomba; Vic.: Melbourne, Gisborne, Walpeup; Tas.: Hobart, Cradle Mt., Strahan; S. Aust.: Adelaide, Renmark, Wilpena; W. Aust.: Albany, Nannup, Beverley, Waroona, Perth, Cunderdin, Kalgoorlie.

Gen. 2. NATAXA.

Nataxa Wlk., Cat. Brit. Mus., v., p. 1179.

Palpi very short, nearly obsolete. Antennae of both sexes bipectinate to apex, pectinations of ♀ short. Posterior tibiae without middle spurs. Forewings with 4 and 5 connate or approximated, all veins from areole separate, subapical crossbar from 10 to 9 shortly beyond their bifurcation. Hindwings with 4 and 5 connate or approximated, 6 and 7 connate or short-stalked, 12 diverging widely from cell, connected with it at ¼ by 11, which is strongly developed.

There is only one species.

2. NATAXA FLAVESCENS.

Perna ? flavescens Wlk., Cat. Brit. Mus., v., p. 1128.—*Nataxa flavifascia* Wlk., *ib.*, v., p. 1179.—*N. rubida* Wlk., *ib.*, xxxii., p. 512.—*Dicreaga ochrocephala* Feld., Reise Nov., Pl. 100, f. 2.

♂. 22—31 mm. Head reddish-ochreous. Antennae fuscous. Thorax brown or reddish-brown. Thorax fuscous-brown, underside and tuft paler. Legs brownish; anterior coxae ochreous. Forewings elongate-triangular, costa sinuate, apex pointed, termen nearly straight, strongly oblique, longer than dorsum; fuscous more or less suffused with reddish; ill-defined reddish spots near base, on costa before apex, and sometimes on mid-costa; an ochreous costal spot at ⅘, from which a slender ochreous line usually proceeds to ⅔ dorsum; cilia very short, fuscous. Hindwings with termen nearly straight; colour as forewings, but with more reddish suffusion; usually a fine, curved, postmedian, ochreous line; cilia short, ochreous. Underside similar.

♀. 30—40 mm. Head ochreous. Thorax fuscous. Abdomen fuscous, usually with a series of whitish spots on bases of segments on mid-dorsum, and two lateral series on underside, the last dorsal spot is enlarged. Forewings with costa gently arched, termen slightly bowed; fuscous; a whitish blotch on costa from ¼ to middle, containing two subcostal blackish dots, first beyond ¼, second beyond middle; a whitish spot on costa slightly beyond middle, from which usually proceeds a fine sinuate white line to ⅔ dorsum; cilia fuscous. Hindwings with termen rounded; fuscous with ill-defined antemedian and postmedian curved transverse lines; cilia fuscous. Underside similar.

The two sexes differ much, and the ♂ is variable.

Q'land.: Gympie, Brisbane; N.S. Wales: Lismore; Vic.: Melbourne, Gisborne; Tas.: ——.

Gen. 3. APROSITA.

Aprosita Turner, Trans. Roy. Soc. S. Aust., 1914, p. 456.

Palpi 2; second joint with dense long hairs beneath; terminal joint moderate. Head, thorax and abdomen densely clothed with long rough hairs. Posterior tibiae without median spurs. Forewings with 5 from above lower angle of cell, 6 connate or short-stalked from upper angle, areole very long, sometimes open between 9 and 8, 7 and 8 connate or stalked from areole, subapical crossbar from 10 to 9 usually, but not always, developed. Hindwings with discocellulars strongly angled inwards, 3, 4, 5 separate, 6 and 7 connate or stalked, 11 present, 12 widely separate from cell.

The connecting bar between 9 and 8 of the forewings is often feebly developed, and may be absent, leaving the areole open. The subapical crossbar is of the usual type, but sometimes fails to chitinise.

3. APROSITA OBSCURA.

Trichiura obscura Wlk., Cat. Brit. Mus., vi., p. 1481.—*Diaphone nana* Feld., Reise Nov., Pl. 99, f. 14.—*Aprosita ulothrix* Turn., Trans. Roy. Soc. S. Aust., 1914, p. 457.

♂. 25—32 mm. Head and thorax grey; sometimes an ochreous-tinged tuft of hairs in front of antenna. Palpi 2; dark-fuscous; terminal joint and apex of second joint whitish-ochreous. Antennae whitish, irrorated with fuscous; pectinations fuscous. Abdomen grey. Legs grey with some whitish hairs. Forewings broadly triangular, costa short, straight, apex very obtusely rounded, termen rounded, scarcely oblique; markings very distinct, dark-fuscous, interruptedly edged with whitish-ochreous; a line from ⅓ costa obliquely outwards to mid-disc, then obliquely inwards to ⅓ dorsum, with a small outward tooth above dorsum; second line from ¾ costa to ¾ dorsum slightly wavy, toothed outwards above middle; a short bar sometimes connects the two lines in middle of disc; sometimes a subterminal line of short streaks on veins; cilia grey. Hindwings with termen strongly rounded; pale-grey; sometimes a pale-fuscous, angulated, antemedian line; sometimes faint fuscous streaks on veins forming a subterminal line; cilia pale-grey. Underside grey; a fuscous median line on both wings.

♀ Unknown.

N. Aust.: Macdonnell Ranges; Q'land.: Duaringa, Blackwater (120 miles west of Rockhampton), near Emerald; N.S. Wales: Broken Hill; S. Aust.: Ooldea.

An inland species.

Gen. 4. ANTHELA.

Anthela Wlk., Cat. Brit. Mus., iv., p. 853.

Palpi moderate, porrect; second joint with loose or appressed hairs; terminal joint short or minute. Posterior tibiae without middle spurs. Forewings with 4 and 5 separate, all veins from areole separate, subapical crossbar from 10 to 9 shortly beyond their bifurcation, sometimes partly or wholly coincident with 9. Hindwings with 4 and 5 separate, 6 and 7 approximated, connate, or stalked, 12 gradually diverging from cell, connected with it before middle by 11, which is often imperfectly or not developed.

Type, *A. ferruginosa* Wlk.

A large genus with some variations in the palpi and neuration, but the latter occur within the limits of the same species in many instances. I recognise 40 species, of which 11 are here described for the first time. Deducting these, there remain 29 species, which have received no fewer than 87 names. This excessive synonymy is due to the great variability of many of the species not having been previously recognised. The sexes often differ, sometimes considerably, in colour, wing-shape, and distinctness of marking. Apart from sexual differences, many species vary much in colour, and in the development of lines on the wings; in some examples these may be very distinct and characteristic, in others of the same species they may be completely obsolete.

Owing to the variability of some of the species the following tabulation must be used with caution:—

1.	Wings wholly unicolorous	2
	Wings not wholly unicolorous	7
2.	Forewings with apex obtusely rounded	3
	Forewings more or less pointed	4

3. Forewings purple-reddish (♂) or pale brownish-ochreous (♀) .. .. *phoenicias*
Forewings dark ochreous-brown (♂) .. .. *adriana*
4. Forewings with termen not oblique .. .. *elizabetha*
Forewings with termen oblique 5
5. Antennae white .. .. *leucocera*
Antennae not white 6
6. Wings grey .. .. *clementi*
Wings reddish or whitish (♂) or brownish (♀) .. .. *rubicunda*
7. Forewings without discal dots 8
Forewings with one or two discal dots 11
8. Forewings with blackish costal edge .. .. *linopepla*
Forewings without blackish costal edge 9
9. Forewings with brownish interneural streaks .. .. *neurospasta*
Forewings without interneural streaks 10
10. Forewings with a nearly straight postmedian line .. .. *varia ab.*
Forewings without postmedian line, but with subterminal dots .. *elizabetha*
11. Forewings with only one discal dot 12
Forewings with two discal dots or spots 16
12. Wings more or less reddish 13
Wings pale-ochreous or whitish-grey without reddish tinge 14
13. Forewings with reddish lines .. .. *hyperythra*
Forewings with lines represented by fuscous dots .. .. *ferruginosa*
14. Forewings with discal spot white-centred .. .. *unisigna*
Forewings with discal dot wholly fuscous 15
15. Forewings without ochreous tinge, usually with an antemedian line *achromata*
Forewings pale ochreous-grey, no antemedian line .. .. *habroptila*
16. Both wings with second discal spot enlarged into a white blotch .. *guenei*
Wings not so marked 17
17. Forewings dark-fuscous with four transverse denticulate white lines *denticulata*
Forewings not so 18
18. Hindwings dark-fuscous with orange terminal band .. .. *ostra*
Hindwings not so 19
19. Forewings wholly without transverse lines 20
Forewings more or less marked with transverse lines 23
20. Forewings reddish or brown .. .. *asterias*
Forewings yellow 21
Forewings fuscous or grey 22
21. Forewings with costa straight, apex slightly produced .. .. .. *callixantha ab.*
Forewings with costa more or less arched, apex not produced .. *canescens ab.*
22. Forewings with discal spots blackish, sometimes pale-centred .. *ocellata ab.*
Forewings with discal spots whitish .. .. *figlina*
Forewings with discal spots brownish-ochreous .. .. *reltoni*
23. Forewings with discal spots large, blackish; sometimes pale-centred .. 24
Forewings with discal spots dot-like or not blackish 26
24. Forewings with a white crenated line, its loops touching subterminal line and termen .. .. *oressarcha*
Forewings without such line 25
25. Wings pale-ochreous .. .. *ochroptera*
Wings mostly fuscous .. .. *ocellata*
26. Forewings with postmedian line nearly straight, but sharply bent inwards beneath costa 27
Forewings with postmedian line not so formed 28
27. Forewings with discal dots not white-centred .. .. *varia*
Forewings with discal dots white-centred, at least on underside .. .. *acuta*
28. Forewings fuscous without ochreous or brownish tinge 29
Forewings brownish, yellow, or reddish 35
29. Hindwings ochreous or ochreous-tinged 30
Hindwings not ochreous-tinged 32
30. Hindwings deep-ochreous .. .. *ariprepes* ♂
Hindwings pale-ochreous or ochreous-tinged 31
31. Forewings with an angulated median line, touching second discal spot *stygiana* ♂

Forewings with a sinuate postmedian line touching second discal spot .. *magnifica* ♂
32. Hindwings fuscous 33
Hindwings whitish 34
33. Forewings with a broad, whitish, strongly dentate, subterminal suffusion .. .. *asciscens*
Forewings with a fine whitish subterminal line .. .. *magnifica* ♀
34. Abdomen reddish-brown on dorsum .. .. *magnifica* ♀ *ab.*
Abdomen grey .. .. *tetraphrica*
35. Forewings with postmedian line bent inwards to before middle of dorsum .. *allocota*
Forewings with postmedian line not so bent 36
36. Forewings with apex acute 37
Forewings with apex not acute 39
37. Wings reddish 38
Wings yellow .. .. *callixantha*
Wings brownish .. .. *repleta*
38. Forewings with broad postmedian line, hindwings with termen well rounded .. .. *phaeodesma*
Forewings with fine postmedian line, hindwings with termen only slightly rounded .. .. *addita*
39. Head whitish .. .. *excellens*
Head not whitish 40
40. Wings yellow or pale ochreous-grey 41
Wings reddish or brownish 42
41. Forewings with discal spots white-centred .. .. *heliopa*
Forewings with discal spots not white-centred .. .. *canescens*
42. Wings without fuscous marginal or submarginal band or shade .. . *pyrrhica*
Wings with fuscous marginal or submarginal band or shade 43
43. Wings orange-ochreous with dark terminal band (♂) or ochreous-brown (♀) .. .. *connexa*
Wings reddish or brownish (♂) or grey (♀) without terminal band .. *nicothoe*

4. Anthela phoenicias.

♂ *Anthela phoenicias* Turn., Trans. Roy. Soc. S. Aust., 1902, p. 182.—♀ *A. aspilota* Turn., *ib.*, p. 182.

♂. 35—40 mm. Head and thorax purple-reddish. Palpi 2½; terminal joint moderate; purple-reddish. Antennae purple-reddish. Abdomen and legs purple-reddish. Forewings broadly triangular, costa straight, apex obtusely rounded, termen bowed, scarcely oblique; purple-reddish; cilia concolorous. Hindwings with termen rounded; as forewings. Underside similar.

♀. 44—46 mm. Differs from ♂ in being uniformly pale-ochreous, without reddish tinge.

I formerly identified this with *rubicunda* Swin., but, having now a series, I find it differs from this in the shape of the forewings. The coloration of the ♂ appears constant in Queensland, but a ♂ from Port Darwin is pinkish-grey.

N. Aust.: Port Darwin (W. K. Hunt in S. Aust. Mus.); N. Qld.: Claudie R., Cairns, Stannary Hills; Qld.: Emerald, Brisbane, Stanthorpe.

5. Anthela rubicunda.

Darala rubicunda Swin., Ann. Mag. Nat. Hist., (7), ix., 1902, p. 419.—*D. pudica* Swin., *ib.*, p. 419.

♂. 40—43 mm. Head, palpi, and thorax purple-reddish, pinkish, grey, or grey-whitish. Antennae reddish or whitish; pectinations fuscous. Palpi 1½ to 2; terminal joint very short; reddish or whitish. Abdomen reddish or whitish, with some ochreous suffusion towards base of dorsum. Legs reddish or whitish. Forewings triangular, costa straight, apex round-pointed, termen bowed, oblique;

purple-reddish, pinkish, grey, or whitish; cilia concolorous, or pinkish. Hindwings with 6 and 7 connate or stalked, 11 present but usually weak; termen rounded; colour as forewings. Underside similar.

Best distinguished from *phoenicias* by the longer, pointed forewings with more oblique termen; the palpi appear also to be rather shorter, with shorter terminal joints. Unlike that species the coloration appears to be very variable.

S. Aust.: Bungaree (Hawker, in South Australian Museum); N.W. Aust.: Roeburne, Hammersley Range, Monte Bello Is., Wyndham.

There is a ♀ in the South Australian Museum from Beverley, W.A. (Duboulay),—expansion 60 mm., colour uniform pale-brown, wings rather thinly scaled,—which I refer to this species, but further evidence is required to confirm this.

6. Anthela adriana.

Darala adriana Swin., Ann. Mag. Nat. History., (7), ix., 1902, p. 419.

♂. 30—40 mm. Head, palpi, and thorax brown. Antennae ochreous-grey. Abdomen and legs brownish. Forewings triangular, costa straight, apex rounded, termen bowed, scarcely oblique; ochreous-brown, sometimes with a dull-purplish suffusion; cilia concolorous. Hindwings with termen strongly rounded; 6 and 7 stalked, 11 present, as forewings.

Smaller than *rubicunda* and much more dingy in colour. There are four examples, including the type, in the British Museum.

N. Qld.: Herberton (F. P. Dodd); N. Aust.: Roebuck Bay; N.W. Aust.: Sherlock River.

7. Anthela leucocera,* n.sp.

♂. 48 mm. Head bright reddish-brown. Palpi 2; reddish-brown, external surface fuscous. Antennae white, pectinations fuscous. Thorax bright reddish-brown, becoming duller posteriorly. Abdomen dull reddish-brown. Legs fuscous; coxae and femora bright reddish-brown. Forewings triangular, costa straight, apex pointed, termen bowed, scarcely oblique; dull reddish-brown without markings; cilia concolorous. Hindwings with termen gently rounded; 6 and 7 stalked, 11 absent; as forewings. Underside similar.

The white antennae contrast strikingly with the general reddish-brown colouring. Type in Coll. Lyell.

N.S.W.: Hornsby, near Sydney, in March; one specimen.

8. Anthela clementi.

Darala clementi Swin., Ann. Mag. Nat. Hist., (7), ix., 1902, p. 81.

♂ ♀. 36—50 mm. Head, palpi, antennae, and thorax grey. Abdomen pale-grey. Legs grey. Forewings triangular, costa straight, apex tolerably pointed, termen strongly bowed, slightly oblique; grey irrorated with ochreous-whitish; sometimes a fuscous spot at end of cell; cilia ochreous-whitish. Hindwings with termen strongly rounded; connecting bar between 8 and cell imperfectly developed; grey mixed with ochreous-whitish; cilia ochreous-whitish.

Very similar to *rubicunda*, but wholly different in coloration. There are five examples, including the type, in the British Museum, and three in the Oxford Museum from Towranna Plains, between Yule River and Sherlock River, N.W. Aust. There is also a pair in Coll. Lyell from Roeburne.

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* λευκοκερος white-horned.

9. ANTHELA ELIZABETHA.

Odonestis elizabetha, White, Grey's Discovery in Australia, ii., Appendix, p. 478.—*Darala rubescens,* Wlk., Cat. Brit. Mus., xxxii., p. 370.

♂. 44—50 mm. Head brown or ochreous-grey-whitish; face and palpi brown. Antennae ochreous-whitish; pectinations fuscous. Thorax brown or ochreous grey-whitish. Abdomen pale-ochreous. Legs brown. Forewings triangular, costa nearly straight, apex tolerably pointed, termen bowed, not oblique; ochreous-grey-whitish, sometimes brownish-tinged; sometimes a subterminal series of ochreous-fuscous dots (but these are absent in two out of three examples); cilia concolorous. Hindwings with 11 absent; termen nearly straight, apex broadly rounded; pale reddish; cilia ochreous-grey-whitish or concolorous.

There are three examples, including both White's and Walker's types, in the British Museum. The latter is an example with brown head and thorax and slightly brownish forewings. The wing shape of this species is characteristic.

W. Aust.: Albany.

10. ANTHELA LINOPEPLA,* n.sp.

♀. 45 mm. Head and thorax white. Palpi 1½; fuscous. Antennae white; pectinations fuscous-tinged. Abdomen white; dorsum of second and penultimate segments ochreous-tinged. Legs whitish; anterior pair pale-fuscous. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, oblique; white; a narrow fuscous costal streak from base to apex; cilia white. Hindwings with termen slightly rounded; 6 and 7 connate, 11 present; white; cilia white. Underside similar.

N. Aust.: Thirty miles east of Darwin, in April; one specimen received from Mr. G. F. Hill.

11. ANTHELA NEUROSPASTA.

Anthela neurospasta Turn., Trans. Roy. Soc. S. Aust., 1902, p. 182.—*A. ochroneura* Turn., Proc. Roy. Soc. Q'land., 1915, p. 25.

♂. 36 mm. Head and thorax whitish. Palpi 2; pale-ochreous. Antennae white; pectinations fuscous. Abdomen pale-ochreous, tuft and underside whitish. Legs whitish; anterior and middle pairs fuscous anteriorly. Forewings broadly triangular, costa straight, apex obtusely rounded, termen bowed, scarcely oblique; whitish, with ochreous-brown interneural streaks; in dark examples the white is reduced to little more than streaks on veins; cilia whitish. Hindwings with termen rounded; 6 and 7 connate, 11 absent; as forewings. Underside similar, but with dark colouring more broadly suffused.

N. Aust.: Stapleton; N.W. Aust.: Wyndham. (The locality Cooktown was probably based on an error.)

12. ANTHELA FERRUGINOSA.

Anthela ferruginosa Wlk., Cat. Brit. Mus., iv., p. 854.—*Darala parva* Wlk., *ib.*, iv., p. 892.—*D. minuta* Swin., Cat. Oxf. Mus., i., p. 210.

♂. 26—34 mm. ♀. 34—38 mm. Head and thorax dark-reddish, sometimes rather paler. Palpi 2½; reddish, terminal joint whitish-ochreous. Antennae whitish; pectinations fuscous. Abdomen more or less reddish. Legs reddish;

* λινόπεπλος, clothed in linen.

tibiae and tarsi paler and ochreous-tinged. Forewings triangular, costa straight, apex round-pointed, termen bowed, not, or only slightly, oblique; reddish, varying somewhat in tinge, occasionally with some fuscous irroration; antemedian line usually marked only by fuscous dots on cubitus and anal veins, but sometimes more developed; a fuscous subcostal discal spot at ½, rarely with whitish centre; a series of fuscous dots on veins parallel to termen at ¾; cilia concolorous. Hindwings with termen rounded; 6 and 7 connate or short-stalked, 11 absent; reddish; discal spot and subterminal dots and cilia as forewings. Underside similar but subterminal dots may be absent.

Ab. 1. A small ♀ (29 mm.) from Birchip without reddish tinge, subterminal dots absent in forewings, indistinct in hindwings, but with general fuscous irroration.

Ab. 2. A large reddish ♀ (42 mm.) from Ferntree Gully, with all markings obsolete except discal spot on forewings.

Walker's type is a faded ♀, not a ♂ as he states.

Qld.: Bundaberg, Eidsvold, Brisbane, Toowoomba, Killarney; N.S. Wales: Sydney; Vic.: Gippsland, Brentwood, Birchip, Ferntree Gully, Inverloch (on coast midway between Western Port Bay and Wilson Promontory); S. Aust.: Murray Bridge; Tas.: ——.

13. Anthela hyperythra,* n.sp.

♂. 34—36 mm. Head and thorax pale-reddish. Palpi 2½; reddish-ochreous. Antennae pale-reddish; pectinations fuscous. Abdomen pale-reddish, dorsum of three basal segments ochreous. Legs whitish-ochreous; coxae and femora reddish. Forewings triangular, costa almost straight to near apex, apex round-pointed, termen strongly bowed, slightly oblique; pale-reddish, with general whitish irroration; a darker median discal dot; an indistinct antemedian line; a dark line at ¾ parallel to termen; cilia pale-reddish irrorated with whitish. Hindwings with termen strongly rounded; 6 and 7 connate or short stalked, 11 absent or feebly developed; reddish with some whitish irroration, but darker than forewings; cilia reddish. Underside reddish without markings.

♀. 42 mm. Much paler, with markings obsolete.

N. Aust.: Darwin, in November and December; 5 specimens received from Mr. F. P. Dodd.

14. Anthela achromata.

Anthela achromata Turn., Trans. Ent. Soc., 1904, p. 481.

♂. 26—34 mm. Head whitish. Palpi 2; brownish. Antennae whitish; pectinations fuscous. Thorax and abdomen whitish-grey. Legs whitish-ochreous or pale-reddish, with whitish-ochreous hairs. Forewings triangular, costa nearly straight, apex tolerably pointed, termen slightly bowed, slightly oblique; whitish-grey or pale-grey; costal edge towards base reddish; markings fuscous, usually distinct, sometimes nearly obsolete; a wavy transverse line at ¼; a discal dot beneath midcosta; a series of dots or short streaks on veins, sometimes united into a crenulate line, at ¾; cilia concolorous. Hindwings with termen rounded; 6 and 7 connate or stalked, 11 present or absent; as forewings, but without first line; discal dot and second line may be obsolete. Underside similar, but with slight reddish suffusion; first line on forewings not developed.

* ὑπέρυθρος, somewhat red.

N. Aust.: Darwin, Stapleton; N. Qld.: Thursday Island, Cairns, Stannary Hills, Mt. Garnet, Mt. Molloy.

15. ANTHELA HABROPTILA,* n.sp.

♂. 46 mm. Head and thorax pale ochreous-grey. Palpi 2; pale-fuscous. Antennae white; pectinations grey. Abdomen and legs whitish-ochreous. Forewings triangular, costa nearly straight, apex round-pointed, termen bowed, slightly oblique; pale ochreous-grey; a fuscous discal dot beneath midcosta; a very faint line from ⅗ costa, slightly curved outwardly, then straight to ⅗ dorsum; a subterminal line of fuscous dots on veins; cilia pale ochreous-grey. Hindwings with termen rounded; 6 and 7 stalked, 11 absent; as forewings, but slightly paler and without markings, except a few subterminal dots. Underside similar; but forewings without postmedian line; hindwings with two discal dots and subterminal line of dots fuscous.

W. Aust.: Kalgoorlie, in June (Duboulay); one ♂ type in National Museum, Melbourne.

16. ANTHELA UNISIGNA.

Anthela unisigna, Swin., Trans. Ent. Soc., 1903, p. 447.

♂. 60 mm. Head brown; face fuscous, sides brown. Palpi brown, apices fuscous. Antennae grey-whitish, pectinations fuscous. Thorax brown mixed with fuscous, some of the hairs whitish towards apex. Abdomen reddish-brown; tuft ochreous-whitish. Legs brown; tarsi fuscous mixed with whitish-ochreous. Forewings triangular, costa straight to ⅘, thence gently arched; apex tolerably pointed, termen bowed, moderately oblique; ochreous-whitish; a straight, transverse, fuscous line from costa beyond middle to ⅗ dorsum; in this a white, subcostal, discal spot outlined with dark-fuscous; a broad terminal band of fuscous suffusion; cilia whitish mixed with fuscous. Hindwings with termen slightly rounded; 11 present; whitish-ochreous, more yellowish towards base; a moderate fuscous terminal band; cilia whitish mixed with fuscous. Underside whitish; forewings with discal spot as on upper side, transverse line faintly marked, a yellowish suffused streak from base to discal spot.

Described from the British Museum type.

N.W. Aust.: Sherlock River.

17. ANTHELA GUENEI.

Teara guenei Newm., Trans. Ent. Soc., 1856, p. 284, Pl. 18, f. 9.

♂ ♀. 48—62 mm. Head ochreous; face in ♂ fuscous, in ♀ ochreous. Palpi 1; in ♂ fuscous, in ♀ ochreous. Thorax fuscous or ochreous-fuscous. Abdomen in ♂ ochreous-fuscous, in ♀ ochreous with four blackish rings posteriorly. Legs fuscous; coxae and femora ochreous. Forewings triangular, in ♀ elongate-triangular, costa gently arched, apex round-pointed, more pointed in ♀, termen slightly bowed, slightly oblique, more strongly in ♀; dark-fuscous; costal edge ochreous; a nearly circular, rather large, white spot beneath ¼ costa; a large white blotch slightly beyond middle; cilia ochreous. Hindwings with termen slightly rounded; 6 and 7 connate or stalked, 11 present or absent; as forewings but basal spot smaller. Underside similar.

* ἁβρόπτιλος, soft-winged.

This appears to be a rare species. The ordinary discal spots are enlarged, the posterior especially, so as to give it, in conjunction with the uniform dark-fuscous colouration and yellowish cilia of both wings, a very distinctive facies. I suggest that it is a mimic of *Nyctemera amica* White.

Qld.: Crow's Nest, near Toowoomba, in September; N.S. Wales: Sydney.

18. Anthela denticulata.

Teara denticulata Newm., Trans. Ent. Soc., 1856, p. 283.—*Darala basigera* Wlk., Cat. Brit. Mus., xxxii., p. 372.—*D. undulata* Feld., Reise Nov., Pl. 98, f. 11.

♂ ♀. 46—54 mm. Head and thorax fuscous. Palpi $1\frac{1}{3}$; fuscous. Antennae white; pectinations fuscous. Abdomen fuscous, towards apex mixed with whitish. Legs fuscous; middle and posterior tibiae white at base and apex. Forewings triangular, costa nearly straight, very slightly sinuate, apex pointed, termen bowed, slightly oblique; fuscous; markings white; a sub-basal angulated transverse line; a discal spot at $\frac{1}{3}$ and another about middle; a finely crenulate line from costa beyond middle, through, or just posterior to, second discal spot, slightly curved outwards beneath costa, thence oblique to mid-dorsum; a third line at $\frac{4}{5}$, similar to median line, except that its anterior edge only is crenulate, the posterior edge nearly straight; a terminal line more or less crenulate; cilia fuscous. Hindwings with termen gently rounded; 6 and 7 connate, 11 absent or weakly developed; white with fuscous markings; a waved transverse line at about $\frac{1}{4}$; a crenulate transverse median line; a subterminal band, crenulate posteriorly; cilia fuscous. Underside of both wings similar to upperside of forewings.

Vic.: Melbourne; S. Aust.: Adelaide; W. Aust.: Kalgoorlie.

19. Anthela ostra.

Anthela ostra Swin., Trans. Ent. Soc., 1903, p. 447.—*A. chrysocrossa* Turn., Proc. Roy. Soc. Q'land., 1915, p. 24.

♂. 38 mm. Head fuscous; back of crown ochreous. Palpi $2\frac{1}{2}$; fuscous, undersurface ochreous. Antennae pale-ochreous, pectinations fuscous. Thorax fuscous, bases of patagia ochreous. Abdomen with dense long hairs especially posteriorly; fuscous. Legs fuscous; upper surface of posterior tibiae irrorated with ochreous. Forewings triangular, costa straight, apex round-pointed, termen bowed, oblique; fuscous with some ochreous irroration; markings ochreous; a costal streak from base, gradually attenuating to about $\frac{3}{4}$; a circular discal spot beneath $\frac{1}{3}$ costa, and another rather larger beneath mid costa; a fine, deeply crenulate, subterminal line; cilia pale-ochreous, bases partly fuscous. Hindwings with termen rounded; 6 and 7 short-stalked, 11 absent; dark-fuscous; an ochreous discal dot before middle; a narrow, orange-ochreous, terminal band, deeply indented anteriorly, with slight fuscous irroration; cilia ochreous. Underside of forewings ochreous with some fuscous suffusion, central discal spot only, and a subterminal series of dark-fuscous interneural spots; of hindwings as upper side, but with two ochreous discal spots, at $\frac{1}{3}$ and $\frac{1}{2}$, the latter larger.

This species is nearest to *A. denticulata* Newm.

N. Aust.: Batchelor, Adelaide R.

20. Anthela asterias.

Darala asterias Meyr., Trans. Roy. Soc. S. Aust., 1891, p. 192.—*D. uniformis* Swin., Cat. Oxf. Mus., i., 1892, p. 210.—*Anthela niphomacula* Low., Trans. Roy. Soc. S. Aust., 1905, p. 175.—*A. callispila* Low., *ib.*, p. 175.

♂. 42—50 mm. Head, thorax, and abdomen reddish-brown or ochreous-brown. Palpi 2¼; reddish- or ochreous-brown. Antennae reddish- or ochreous-brown; pectinations fuscous. Legs reddish- or ochreous-brown. Forewings triangular, costa straight to near apex, apex pointed, termen slightly bowed, slightly oblique; reddish-brown, ochreous-brown, or pale-pink; two white discal spots edged with fuscous; first beneath costa at ⅓, second beneath costa slightly beyond middle; rarely the basal spot is not developed; cilia concolorous. Hindwings with termen more or less rounded; 6 and 7 connate or stalked, 11 present; as forewings, but without discal spots, or with one minute spot only. Underside similar, but discal spots on forewing may be obsolete; spot on hindwing better developed, and rarely preceded by a smaller spot.

N. Qld.: Stannary Hills, near Herberton; Qld.: Rockhampton, Duaringa, Emerald, Gayndah, Charleville; N.S. Wales: Broken Hill; S. Aust.: Beltana.

Meyrick's type is said to be from Melbourne, but I doubt whether this is correct; the species, however, probably occurs in the north-west of Victoria.

21. Anthela figlina.

Darala figlina Swin., Ann. Mag. Nat. Hist., (7), ix., 1902, p. 81.

♂. 30—32 mm. Head grey; face whitish-ochreous. Palpi rather short (scarcely over 1); grey mixed with whitish-ochreous. Antennae whitish-grey, pectinations darker. Thorax grey. Abdomen grey; base of dorsum ochreous-brown. Legs grey. Forewings triangular, costa straight, apex tolerably pointed, termen nearly straight, scarcely oblique; grey, closely irrorated with whitish-ochreous; two whitish discal spots; first beneath ¼ costa, oval; second before ⅔, somewhat rectangular; cilia whitish-ochreous. Hindwings, termen only slightly rounded; 11 present; as forewings.

There are three examples in the British Museum and two examples in the Oxford Museum.

N.W. Aust.: Towranna Plains, between Yule River and Sherlock River.

22. Anthela reltoni.

Darala reltoni Luc., Trans. Nat. Hist. Soc. Q'land., i., 1895, p. 106.—*Anthela pyromacula* Low., Trans. Roy. Soc. S. Aust., 1905, p. 76.

♂. 50—56 mm. Head, palpi, and thorax fuscous. Antennae fuscous. Abdomen fuscous, dorsum sometimes ochreous-tinged. Legs fuscous. Forewings broadly triangular, costa straight to middle, thence gently arched, apex rather acutely pointed, termen bowed, slightly oblique; fuscous finely irrorated with whitish; veins narrowly darker fuscous; a small circular brownish-ochreous discal spot at ⅔ (at end of cell), narrowly outlined with fuscous; preceded by a fine longtitudinal dark-fuscous line in cell, in one example interrupted by a narrow, longitudinal, elongate, brownish-ochreous spot; sometimes a dark-fuscous streak in disc above and parallel to vein 1; cilia fuscous. Hindwings with termen rounded; colour and cilia as forewings, but paler and without spots. Underside fuscous, with a minute pale spot at end of cell in each wing.

Qld.: Charleville; the type now in Queensland Museum; Adavale, in May. Two specimens, the latter in my own collection. N.S. Wales: Broken Hill (Lower).

23. Anthela varia.

Darala varia Wlk., Cat. Brit. Mus., iv., p. 890.—*D. integra* Wlk., *ib.*, iv., p. 893.—*D. humata* Wlk., *ib.*, iv., p. 895.—*Colussa odenestaria* Wlk., *ib.*, xxi., p.

288.—*Darala pinguis* Wlk., *ib.*, xxxii., p. 372.—*Colussa uvaria* Wlk., *ib.*, xxxv., p. 1576.—*D. latifera* Wlk., Trans. Ent. Soc., 1862, p. 266.—*D. caniceps* Wlk., *ib.*, p. 269.—*D. limonea* Butl., Cist. Ent., i., 1874, p. 291.—*D. succinea* Luc., Proc. Linn. Soc. N.S. Wales, 1891, p. 290.—*D. scortea* Luc., *ib.*, 1891, p. 290.

♂. 62—76 mm. Head, thorax, and abdomen yellow or pinkish, rarely pale-grey; face fuscous or purple-fuscous, rarely yellow. Palpi 1½; fuscous or purple fuscous. Antennae yellow, very rarely whitish; pectinations fuscous. Legs fuscous or purple-fuscous, often irrorated with whitish; coxae and femora ochreous-tinged, yellow, or pinkish; apices of femora white. Forewings triangular, costa straight to past middle, thence arched, apex pointed, termen slightly sinuate beneath apex, slightly oblique; yellow or pinkish, rarely grey or ochreous-grey; markings fuscous, rarely reddish; sometimes a crenulate transverse line at about ⅓; a discal dot beneath ⅓ costa, and another larger beyond middle, not white-centred, rarely obsolete; exceptionally an outwardly curved crenulate line at about ½, touching, or just beyond, first discal dot; a line from ¾ costa to ⅔ dorsum always present, edged posteriorly with yellow, nearly straight, but sharply bent inwards just beneath costa; occasionally this is followed by some purple-fuscous suffusion; a deeply crenulate subterminal line, sometimes reduced to a series of dots, or wholly obsolete; cilia yellowish or pinkish, rarely grey. Hindwings with termen rounded, tornus prominent, or forming a rounded projection; 6 and 7 stalked, 11 present or absent; as forewings, but without discal dots and antemedian lines; subterminal line sometimes closely followed by a similar but more suffused parallel line. Underside similar, but forewings without antemedian lines; hindwings with two discal dots.

♀. 82—110 mm. Forewings with costa strongly arched throughout, apex acute, strongly produced, termen more strongly sinuate; as in ♂ but with more tendency as a rule to obsolescence of markings except postmedian line; sometimes a short, pale, oblique streak from apex.

By an unfortunate error I formerly (Trans. Ent. Soc., 1894, p. 480) attributed the name *acuta* to this species instead of to the following. Both *varia* and *acuta* are characterised by the nearly straight postmedian line bent inwards beneath costa. They are closely allied and both extremely variable, so that it is not easy to give absolutely distinctive characters. The discal dots can usually be relied on, but I have seen a ♀ from Kuranda in which these are wholly white.* *A. varia* is a larger insect, and the ♀ may be distinguished from *acuta* by this, and the more strongly produced apex of forewings.

N. Qld.: Kuranda near Cairns, Stannary Hills; Qld.: Rockhampton, Brisbane, Stradbroke I.; N.S. Wales: Glen Innes; Vic.: Melbourne, Bairnsdale, Merrigum (120 miles north of Melbourne).

24. Anthela acuta.

Darala acuta Wlk., Cat. Brit. Mus., iv., p. 889.—*D. excisa* Wlk., *ib.*, iv., p. 889.—*D. ferruginea* Wlk., *ib.*, iv., p. 890.—*D. conspersa* Wlk., *ib.*, iv., p. 891.—*D. simplex* Wlk., *ib.*, iv., p. 891.—*D. plana* Wlk., *ib.*, iv., p. 892.—*D. subfalcata* Wlk., *ib.*, iv., p. 894.—*D. falcata* Wlk., *ib.*, iv., p. 895.—*D. cinerascens* Wlk., *ib.*, iv., p. 900.—*Ennomos ? potentaria* Wlk., *ib.*, xxvi., p. 1519.—*D. rufifascia* Wlk., *ib.*, xxxii., p. 370.—*D. delineata* Wlk., *ib.*, xxxii., p. 371.—*D. quadriplaga* Wlk., Trans. Ent. Soc., 1862, p. 269.

♂. 34—62 mm. Head, thorax, and abdomen grey, brownish, ochreous, or reddish; face usually fuscous. Palpi 1½; fuscous or reddish. Antennae yellow

* Perhaps these represent a distinct species not yet clearly differentiated.

or yellowish; pectinations fuscous. Legs fuscous or reddish with whitish irroration; coxae and femora grey or ochreous; apices of femora white. Forewings triangular, costa gently arched, apex acute, termen sinuate, scarcely oblique; grey, whitish-grey, brownish, or ochreous, sometimes with reddish or fuscous discal and terminal blotches and spots, sometimes with fine fuscous irroration; lines fuscous or reddish; sometimes an outwardly-curved dentate line at ¼; a whitish dot nearly always ringed with fuscous beneath costa at ¼, and another in middle; rarely a curved dentate median line at ½; a nearly straight postmedian line from ¾ costa to ⅔ dorsum, sharply bent inwards beneath costa, edged posteriorly by a pale, usually ochreous-tinged line, always present; a subterminal series of dots on veins sometimes united to form a crenulate line; cilia usually concolorous. Hindwings with termen rounded, tornus rather prominent; 6 and 7 connate or stalked, 11 present or absent; as forewings, but with only one discal dot, and that not white-centred, or with none. Underside similar, but less strongly marked; hindwings with two discal dots.

♀. 54—68 mm. Forewings narrower, costa more strongly arched, apex acute and sometimes slightly produced.

Southern examples have the wings more or less irrorated with fuscous. The aberration of the ♂ with blotched wings is common in Southern Queensland and New South Wales. Specimens from North Queensland are rather larger and not so easily distinguished from *varia*.* An occasional aberration has the discal dots of the forewings large and wholly fuscous on the upperside.

N. Qld.: Cape York, Cooktown, Cairns, Atherton; Qld.: Rockhampton, Brisbane, Mt. Tambourine; N.S. Wales: Glen Innes, Ebor, Dorrigo, Gosford, Sydney; Vic.: Melbourne, Western Port, Wandin, Wilson's Promontory, Inverloch, Trafalgar, Gisborne, Meeniyan; Tas.: Hobart, Swansea, Sheffield, Ulverstone.

25. Anthela oressarcha,† n.sp.

♂. 54—60 mm. Head, thorax, and abdomen pale-fuscous. Palpi 2, terminal joint rather long; whitish-ochreous; external surface of second joint fuscous. Antennae whitish; pectinations fuscous. Legs pale-fuscous. Forewings triangular, costa slightly arched, apex round-pointed, termen bowed, oblique; pale-fuscous; slightly reddish towards base; veins darker-fuscous; an outwardly-curved whitish line from ¼ costa to ⅓ dorsum, posteriorly suffusedly edged with dark-fuscous; a longitudinally oval discal spot beneath ¼ costa, dark fuscous, sometimes with white centre; a second discal spot below middle, circular, dark-fuscous with white centre; a whitish line from ½ costa, sharply outwardly curved beneath costa, then inwardly oblique to mid-dorsum; a similar line, but less sharply curved, and edged anteriorly with dark-fuscous, from ¾ costa to ⅔ dorsum; a strongly crenated whitish line, acutely dentate anteriorly, the apices of dentations touching third line on veins, the rounded crenations posteriorly touching termen; ciliations pale-fuscous. Hindwings with termen slightly rounded; 6 and 7 stalked, 11 absent; as forewings, but without first line; discal dots faint or obsolete. Underside similar, but without first and second line on forewings; second line and discal dots with white centres present in hindwings.

♀. 75—78 mm. Forewings with apex more acutely pointed, termen more oblique; first line faintly marked. Hindwings with apex more acute, termen nearly straight.

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* Perhaps these represent a distinct species not yet clearly differentiated.

† ὀρεσσαρχος, lord of the mountain.

N.S. Wales: Mt. Kosciusko (5000ft.) in January; six specimens taken in the hotel, into which they had been doubtless attracted by light.

26. ANTHELA CNECIAS,* n.sp.

♀. 84 mm. Head ochreous-whitish; face whitish-ochreous. Palpi about 1; whitish-ochreous. Antennae ochreous-whitish; pectinations in ♀ 1, fuscous. Thorax and abdomen pale-ochreous. Forewings elongate-triangular, costa straight to ⅔, thence arched, apex round-pointed, termen bowed, oblique; pale-ochreous; a broad whitish streak along costa nearly to apex, interrupted at ⅔; a longitudinally elongate discal spot at ¼, whitish outlined with fuscous; a similar, but transversely elongate, somewhat reniform spot slightly beyond middle; a slender whitish line, slightly sinuate, from ¾ costa to beyond middle of dorsum; cilia pale-ochreous. Hindwings with apex prominent, termen slightly rounded; 11 present; pale-ochreous; a fuscous, pale-centred discal spot at ⅓; cilia pale-ochreous. Underside similar, but with two whitish, fuscous-edged spots on hindwings.

Nearly allied to *A. ocellata,* but much larger, differently coloured, and of more simple pattern. The ♀ example, which I have described, is in the British Museum, and is labelled "Tasmania." It was described by Walker (Cat. Brit. Mus., iv., p. 887) as *ocellata* var. γ.

27. ANTHELA OCELLATA.

Darala ocellata Wlk., Cat. Brit. Mus., iv., 1855, p. 887.—*Ommatoptera tetrophthalma,* H.Sch., Ausser. Schmet., 1856, f. 506,507.—*Darala ochroptera* Low., Trans. Roy. Soc. S. Aust., xvi., 1892, p. 14.—*Anthela symphona* Turn., Trans. Ent. Soc., 1904, p. 480.—*Colussa psammochroa* Low., Trans. Roy. Soc. S. Aust., 1908, p. 112.—*Anthela nigristigma* Fawcett, Proc. Zool. Soc., 1917, p. 248.

♂. 40—46 mm. Head brown. Palpi 1½; brown. Antennae whitish; pectinations 7, fuscous. Thorax brown with some fuscous admixture. Abdomen pale-brown. Forewings triangular, costa straight to near apex, apex round-pointed, termen bowed, slightly oblique; brown-whitish, centre of disc and base sometimes suffused with fuscous; dark-fuscous discal spots at ⅓ and middle, the second sometimes with some central whitish scales; sometimes a dark-fuscous line, more or less interrupted, from near base of costa obliquely outwards, then rounded to ⅓ dorsum, nearly touching first discal spot; usually a fine fuscous line, sometimes edged posteriorly with whitish, from ¾ costa obliquely outwards, curved outwards beneath costa, and thence nearly straight to ¾ dorsum; shortly posterior to this a dark-fuscous line, sometimes reduced to a series of dots on veins; terminal edge rarely fuscous; cilia whitish-brown. Hindwings with termen slightly rounded; 6 and 7 stalked, 11 absent; rarely a postmedian, whitish, transverse line; a subterminal series of minute fuscous dots; cilia whitish-brown. Underside whitish-brown with subterminal series of fuscous dots, and two, whitish-centred, discal spots on each wing.

♀. 54—67 mm. Antennal pectinations 1¾. Forewings more elongate; as in ♂, but markings less distinct; sometimes with a broad, whitish, costal streak; discal spots often whitish in centre. Hindwings fuscous-whitish.

This species shows geographical variations, as well as a strong tendency to individual variation. Brisbane examples may have all the markings, except the discal spots, obsolete; the fuscous lines, when present, are usually slender.

* κνήκος, pale yellowish.

Victorian examples resemble closely the more heavily marked Brisbane ♂, but the ♀ often has a whitish costal suffusion, and postmedian white lines, which are not developed in the Brisbane ♀. Tasmanian examples are more distinct, both sexes are darker, the ♂ with much fuscous suffusion and distinct postmedian white lines, the ♀ with a broad, whitish, costal suffusion, but it is impossible to separate them specifically from the mainland form. *A. ochroptera* Low. (= *psammochroa* Low.) is a local race from north-west Victoria and South Australia, in which the wings are whitish or ochreous-whitish, the markings dark and strongly marked.

N. Qld.: Ingham, Townsville; Qld.: Gympie, Nanango, Brisbane; N.S. Wales: Sydney; Vic.: Melbourne, Mildura; Tas.: Launceston, Hobart; S. Aust.: Mt. Lofty, Cootanoorina, Cockburn.

28. Anthela aripreps,* n.sp.

♂. 64 mm. Head and thorax grey with some whitish hairs. Palpi short (1); second joint densely hairy beneath; terminal joint rather long; fuscous with some whitish hairs. Antennae fuscous with a few whitish scales on stalk. Abdomen yellow, towards base mixed with fuscous; tuft pale-yellow; underside whitish. Legs fuscous; apices of femora and tibiae pale yellow. Forewings triangular, costa nearly straight to ⅚, arched before apex, apex rectangular, termen slightly bowed, slightly oblique; fuscous uniformly irrorated with whitish, appearing dark-grey; a large circular white spot, narrowly outlined with dark-fuscous, beneath ¼ costa, and a similar, rather smaller, spot beneath mid costa; lines fuscous; a very indistinct, dentate, outwardly curved line at ¼; a fine, acutely dentate line from ⅔ costa, curved at first outwardly and then inwardly to ⅔ dorsum; a similar line from ⅚ costa to ⅚ dorsum; cilia concolorous. Hindwings with termen rounded; 6 and 7 stalked, 11 absent; yellow; a fuscous discal spot before middle; a curved, slightly dentate, fuscous median, transverse line; a curved, dentate, fuscous, transverse line at ⅔; a broad, dark-grey, terminal band with slight yellowish irroration; cilia dark-grey, apices whitish. Underside whitish with grey irroration; disc of forewings suffused with yellow, except towards costa and termen; discal spots with thicker dark-fuscous rings and smaller white centres; no basal line; postmedian line of both wings reddish; subterminal line as on upperside; a faint, whitish, wavy, submarginal line; two, pale-centred, fuscous, discal spots on hindwing.

This, with *A. magnifica*, *asciscens*, and *stygiana*, forms a natural group. Besides other characters, it differs from *magnifica* in the postmedian line being denticulate, more strongly curved, and posterior in situation, while that of the hindwings is median, not at ⅓. Type in National Museum, Melbourne.

Vic.: Lake Hattah (near extreme N.E. corner of Victoria) in February (J. E. Dixon); one specimen.

29. Anthela stygiana.

Darala stygiana, Butl., Ann. Mag. Nat. Hist., (5), ix., 1882, p. 88.

♂. 74 mm. Head, palpi, and thorax fuscous with a few whitish hairs. Antennae grey-whitish, pectinations fuscous. Abdomen fuscous, sides, except at base, brown, tuft and underside whitish. Legs fuscous; tips of coxal hairs reddish-brown. Forewings rather narrowly triangular, costa straight to ⅘, thence strongly arched, apex tolerably pointed, termen bowed, oblique; fuscous, min-

* ἀριπρεπής, splendid.

utely irrorated with whitish; a minute, white, subcostal, discal dot at ¼; a fuscous line from midcosta obliquely outwards, angled inwards beneath costa, thence slightly inwardly curved, ending on mid-dorsum; a whitish discal spot in this line at angle; two wavy fuscous lines from dorsum before middle to about mid-disc; a faint, very slender, transverse line from ¾ costa to ⅔ dorsum; a faint, fuscous, subterminal line, strongly and coarsely dentate, the large teeth approaching near termen; cilia fuscous, barred with whitish on veins. Hindwings with termen moderately rounded; 11 present; pale-ochreous, towards base suffused with reddish-ochreous, and beyond middle with fuscous; a broad, straight, fuscous line at ⅓; a fine, crenulate, fuscous line at ⅔; cilia fuscous with a few whitish bars. Underside ochreous-whitish with less fuscous suffusion than on upperside, lines and discal dots present, an additional fuscous median dot on hindwings before first line.

Described from the British Museum type.

N.S. Wales: Deniliquin (Lucas, Proc. Linn. Soc. N.S. Wales, 1891, p. 288).

30. ANTHELA MAGNIFICA.

Darala magnifica Luc., Proc. Linn. Soc. N.S. Wales, 1891, p. 286.—*D. xantharcha* Meyr., Trans. Roy. Soc. S. Aust., 1891, p. 191.— *Anthela tritonea* Swin., Trans. Ent. Soc., 1903, p. 448.

♂. 65—100 mm. Head dark-fuscous; face ochreous or brownish. Palpi 1½; fuscous with some whitish hairs, or sometimes mostly pale-ochreous. Thorax dark-fuscous with some whitish hairs. Abdomen whitish, base and a variable extent of dorsum fuscous; sometimes the whole of dorsum is reddish-brown. Legs fuscous, more or less mixed with reddish-brown; apices of femora and tibiae whitish-yellow; anterior tibiae sometimes with whitish hairs. Forewings broadly triangular, costa straight to ⅔, thence strongly arched, apex round-pointed, termen straight, slightly oblique; fuscous with uneven whitish irroration; markings dark-fuscous; an irregularly-bent, outwardly-curved line from ⅕ or ¼ costa to ⅓ or ¼ dorsum; a broadly suffused line from ⅓ costa to ⅖ dorsum, sometimes obsolete; sometimes a white-centred discal spot at ⅓; a larger, similar median spot; a sinuate line from ⅔ costa to ⅗ dorsum, just beyond, or touching, second discal spot; a slender wavy line at ⅘, thickened on costa, sometimes edged posteriorly with whitish; a crenated, whitish, subterminal line from just before apex to tornus; cilia fuscous. Hindwings with termen rounded; 6 and 7 approximated, connate, or short-stalked, 11 present; pale-yellowish suffused with pale-fuscous except towards base, sometimes the median area is whitish; a straight, transverse, pale-fuscous shade at about ⅓; two, indistinct, wavy, subterminal lines, immediately followed by a whitish line; a fuscous terminal band; cilia fuscous. Underside whitish, with more or less grey irroration; forewings with two, rather large, whitish, discal spots edged with fuscous; anterior half of disc more or less suffused with ochreous, lines as on upper side, but first two obsolete; hindwings similar, but without ochreous suffusion; discal spots small or obsolete.

♀. 75—108 mm. Forewings narrower, costa evenly arched, apex acute; markings as in ♂ but more obscure, or partly obsolete. Hindwings fuscous, sometimes whitish towards base; a wavy or crenulate, whitish, submarginal line. Underside as in ♂, or almost wholly fuscous.

I have seen the type of *xantharcha* Meyr., which is in the South Australian Museum. It is a small ♂ (65 mm.) with the abdomen reddish-brown on dorsum,

and the forewings with second and third lines approximated. An example from Cunnamulla is almost exactly similar, and so is another from Victoria. On the other hand, examples from Northam, Western Australia, are almost the same as those from Duaringa, Queensland, being much larger, the males having the abdomen whitish on dorsum, except towards base, which is fuscous. These forms cannot be separated specifically, nor is it easy to see how they can be regarded as local races; perhaps the differences are climatic.

Qld.: Duaringa, Jandowae, Cunnamulla; Vic.: Lake Hattah; S. Aust.: Koolunga; W. Aust.: Beverley, Northam; N.W. Aust.: Derby (W. D. Dodd).

31. ANTHELA ASCISCENS.

Darala asciscens Luc., Proc. Linn. Soc. N.S. Wales, 1891, p. 288.

♂. 85 mm. Head dark-fuscous. Palpi 2; fuscous, with a few whitish hairs. Antennae white mixed with fuscous; pectinations fuscous. Thorax dark-fuscous with a few whitish and reddish hairs. Abdomen reddish-brown; base of dorsum dark-fuscous; tuft and underside whitish. Legs dark-fuscous with whitish and reddish hairs; apices of femora and tibiae pale-yellow. Forewings triangular, costa strongly arched, apex rounded-rectangular, termen nearly straight, moderately oblique; whitish irrorated rather densely with fuscous; markings dark-fuscous; an obscure line from costa near base, strongly and acutely angled outwards beneath costa, and ending on ¼ dorsum; the area between this line and base is more or less blotched with whitish; an obscure line from ¼ costa roughly parallel to the preceding, ending on ½ dorsum; a minute white discal dot in second line; a larger, white, median, discal spot lying in a fuscous longitudinal bar which extends from first dot to termen; a postmedian line from ¾ costa curved outwards around second discal spot, and then inwards to ¾ dorsum; a fine line, straighter than the preceding, before ⅘; a very strongly dentate subterminal line from apex, preceded by a broad, irregular, whitish suffusion; terminal area with broadly suffused longitudinal bars; cilia fuscous barred with white. Hindwings with termen gently rounded; 6 and 7 connate, 11 present; fuscous, darker towards base; a white tornal suffusion giving rise to an indistinct whitish subterminal line; cilia as forewings. Underside of forewings fuscous with some brownish suffusion as far as postmedian line; two whitish discal dots; postmedian area as upperside, but paler; underside of hindwings as forewings.

♀. 95 mm. Similar to ♂, but abdomen with tuft and underside not whitish; forewings with termen more bowed, paler and with markings less distinct; hindwings with a strong, dentate, whitish, subterminal line.

Qld.: Duaringa, Jandowae.

32. ANTHELA TETRAPHRICA,* n.sp.

♂. 50 mm. ♀. 63 mm. Head grey-whitish. Palpi 1½, terminal joint short and concealed in long hairs; fuscous. Antennae reddish; pectinations fuscous. Thorax fuscous with some grey-whitish hairs. Abdomen grey. Legs grey; tibiae and tarsi fuscous mixed with reddish. Forewings elongate-triangular, costa moderately and evenly arched, apex tolerably pointed, termen bowed, strongly oblique; whitish-grey with fuscous irroration, which is less marked towards base and termen; markings fuscous; an outwardly curved line from ¼ costa to ⅓ dorsum; a small grey-centred spot beneath costa at ½, and another

* τετραφριχος, four times rippled.

slightly beyond middle; an outwardly curved line from $\frac{1}{3}$ costa to mid-dorsum, passing just outside first spot; an oblique, wavy, fine line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum; a wavy outwardly-curved line slightly beyond this, followed by a grey submarginal line; cilia grey. Hindwings with termen scarcely rounded; 6 and 7 stalked, 11 present; grey-whitish; two, fine, grey, slightly wavy, transverse lines; first at $\frac{1}{3}$, nearly straight; second subterminal, slightly sinuate; some grey suffusion in terminal half of disc; cilia grey. Underside grey, with lines as on upperside, two discal spots in forewing, one in hindwing.

W. Aust.: Northam; one ♀ specimen received from Mr. L. J. Newman, who has another. Beverley; one ♂ in South Australian Museum.

33. Anthela allocota,† n.sp.

♀. 64 mm. Head and palpi whitish-ochreous. Antennae grey. Thorax and abdomen ochreous-grey-whitish. Legs fuscous; coxae and femora whitish-ochreous. Forewings triangular, costa strongly arched, apex subrectangular, termen slightly bowed, oblique; ochreous-grey-whitish with fine brownish irroration; a whitish discal spot edged with fuscous beneath $\frac{1}{4}$ costa, and another beneath costa before middle; a finely denticulate fuscous line from $\frac{2}{3}$ costa at right angles for a short distance, then abruptly bent inwards and sinuate to dorsum slightly before middle, posteriorly edged with ochreous; traces of a fuscous subterminal line, best marked near costa and dorsum; cilia ochreous-grey-whitish. Hindwings with termen rounded, tornus rather prominent; 6 and 7 connate, 11 present; as forewings, but without discal spots; a dentate fuscous transverse line at $\frac{1}{2}$, posteriorly edged with ochreous, represents median line of forewings. Underside similar, but markings very obscure; two discal spots on hindwings.

The peculiar median line of forewings should make this species easy of recognition.

Vic.: Melbourne; one ♀ type in National Museum, Melbourne.

34. Anthela callixantha.

Darala callixantha Low., Trans. Roy. Soc. S. Aust., 1902, p. 214.—*Anthela flavala* Swin., Trans. Ent. Soc., 1903, p. 452.

♂. 32—35 mm. ♀. 40—46 mm. Head, palpi, thorax, and abdomen yellow; palpi 1. Antennae pale-ochreous; pectinations grey. Legs yellowish. Forewings elongate-triangular, costa straight, apex acute, more so in ♀, termen bowed, slightly oblique; yellow, in ♂ with some fuscous irroration; markings fuscous; a small discal dot at $\frac{1}{3}$ and another at middle, both usually white-centred; sometimes a slightly outwardly-curved, transverse, antemedian line, which may be dentate; sometimes a nearly straight transverse line at $\frac{2}{3}$; sometimes two crenulate subterminal lines; but all lines may be obsolete in ♀; cilia yellow. Hindwings with termen strongly rounded; 6 and 7 stalked, 11 strongly developed; as forewings. Underside similar.

Very variable in the development of the lines which may be strongly marked or quite obsolete in the ♀.

N.W. Aust.: Sherlock River, two ♀ examples, including Swinhoe's type in the British Museum; Wyndham, one ♀ example received from Mr. L. J. Newman; Hammersley Range, three ♂ examples (W. D. Dodd) in the South Australian Museum; W. Aust.: Carnarvon (in British Museum).

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* ἀλλοκοτος, of an unusual kind.

35. Anthela phaeodesma,* n.sp.

♂. 36 mm. ♀. 44—48 mm. Head, palpi, and thorax ochreous with some pinkish hairs. Antennae fuscous, stalk in ♂ partly whitish. Abdomen ochreous sometimes pinkish-tinged. Legs ochreous; anterior tibiae and tarsi pinkish or fuscous. Forewings triangular, proportionately broader in ♂, apex rectangular, termen moderately bowed, scarcely oblique; ochreous suffused with pinkish; lines fuscous; a strongly curved line from ⅓ costa to ¼ dorsum, sometimes faintly marked; a white subcostal dot edged with fuscous at ¼, and another in middle; a broad line from ¾ costa to ⅔ dorsum, nearly straight; midway between this and termen a series of fuscous dots on veins parallel to termen; in ♂ some fuscous suffusion near termen; cilia concolorous. Hindwings with 6 and 7 connate or stalked, 11 absent; termen rounded; as forewings, but without basal line, and with one or no discal dots. Underside similar, but with two discal dots on hindwings.

N. Qld.: Kuranda near Cairns, and Atherton, in April; three specimens.

36. Anthela addita.

Anthela addita Wlk., Cat. Brit. Mus., xxxii., p. 372.

♂ ♀. 40 mm. Head, thorax, and abdomen dull-reddish. Palpi 2; reddish; terminal joint whitish-ochreous. Antennae in ♂ white, in ♀ grey, towards base ochreous; pectinations fuscous. Legs reddish. Forewings triangular, costa nearly straight, slightly sinuate, apex acute, termen bowed, slightly oblique; dull-reddish or ochreous-reddish; markings fuscous; sometimes an irregular outwardly curved line at ¼; a small, whitish-centred, discal spot beneath ¼ costa, and another beneath midcosta; a faint, antemedian, transverse line, sometimes reddish, between discal spots; a slightly curved line, sometimes reddish, sometimes crenulate, from ¾ costa to ⅔ dorsum; a subterminal series of dots on veins, sometimes connected to form a crenulate line; cilia concolorous. Hindwings with termen slightly rounded or nearly straight, apex rounded-rectangular; 6 and 7 separate or connate, 11 weak or absent; as forewings, but with one or no discal spot, and only postmedian and subterminal lines, or with the former obsolete. Underside similar, but markings nearly obsolete; both wings with two discal spots, or with basal spot obsolete.

In size intermediate between *ferruginosa* and *pyrrhica;* from the former it may be distinguished by the two discal spots, and from both by the acute apex of the forewing. Walker's type is a ♀; I have not been able to compare with it the specimens I have described, but I think they are conspecific.

Vic.: Inverloch in February, one ♂ in National Museum, Melbourne; Tas.: Ulverstone, one ♂ in Coll. Lyell. A ♀ from Tasmania in National Museum. Hobart; one ♂ in S.A. Museum.

37. Anthela pyrrhica,† n.sp.

♀. 45—48 mm. Head and thorax dull-reddish, or brownish-ochreous, except face which is reddish. Palpi 2; reddish. Antennae whitish; pectinations fuscous. Abdomen pale-reddish or pale-ochreous. Legs reddish or pale-ochreous. Forewings rather elongate-triangular, costa nearly straight, apex tolerably pointed, termen bowed, oblique; dull-reddish or brownish-ochreous; a pale-fuscous, out-

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* φαιόδεσμος, with dusky band.

† πυρρίχος, reddish.

wardly curved, sub-basal line sometimes faintly indicated; a fuscous discal dot beneath costa just before middle, and a larger spot just beyond middle, fuscous, the second or both with pale centre; a faint, oblique, nearly straight line from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum; a slightly wavy, outwardly curved line beyond this, sometimes reduced to dots on veins; cilia concolorous. Hindwings rather long, termen only slightly rounded; 6 and 7 connate, 11 absent; as forewings, but with only one discal spot, and without postmedian line. Underside similar, but both wings without postmedian line, hindwings sometimes with two discal dots.

The type is a reddish ♀ from Mt. Kosciusko, not unlike *A. ferruginosa* but larger, and readily distinguished by the two discal dots. Mr. Lyell has another ♀, differently coloured, but probably the same species.

N.S. Wales: Mt. Kosciusko in January; Vic.: Gisborne in December. Two specimens.

38. Anthela heliopa.

Darala heliopa Low., Trans. Roy. Soc. S. Aust., 1902, p. 214.

♂. 30—35 mm. Head yellow; face reddish-brown. Palpi 2; reddish-brown. Antennae whitish, towards base fuscous or reddish; pectinations fuscous. Thorax and abdomen yellow. Legs reddish-brown; coxae and femora yellow. Forewings broadly triangular, costa slightly arched, apex rounded-rectangular, termen slightly bowed, not oblique; markings reddish-fuscous; traces of a curved sub-basal line; small white-centred discal spots at $\frac{1}{3}$ and middle; a rather thick straight line from $\frac{3}{4}$ costa to $\frac{3}{4}$ termen; a sinuate line of dots on veins about midway between this and termen; a slight reddish-fuscous irroration towards termen; cilia yellow. Hindwings with termen rounded; 6 and 7 connate or stalked, 11 absent or weakly developed; as forewings, but with only one discal spot. Underside similar, but more heavily marked.

♀. 44 mm. More brownish-yellow; markings purple-fuscous; postmedian line, especially of hindwings, curved; subterminal dots indistinct. Lower's type was a ♀.

N. Qld.: Cooktown, Port Douglas, Cairns, Herberton.

39. Anthela excellens.

Darala excellens, Wlk., Cat. Brit. Mus., iv., p. 902.

♂. 60 mm. Head grey-whitish. Palpi $1\frac{1}{2}$; grey-whitish, upper surface reddish-tinged. Antennae grey-whitish; pectinations 6. Thorax yellow suffused with reddish and, on middle of patagia, with fuscous. Abdomen yellow suffused with reddish. Legs grey-whitish; coxae yellow. Forewings triangular, costa gently arched, more strongly towards apex, apex tolerably pointed, termen scarcely bowed, slightly oblique; yellow with reddish suffusion and some fuscous blotches (probably varietal); a reddish transverse line from $\frac{1}{4}$ costa; a second reddish line from $\frac{1}{2}$ costa, nearly straight to $\frac{3}{4}$ dorsum, followed closely by a similar but more slender line; three, fuscous, coarsely crenate lines between this and termen; cilia yellow. Hindwings with termen slightly rounded; 11 present; as forewings, but without first line. Underside similar, but without antemedian and with only one subterminal line, the normal discal dots, which on the upper side are obscured by fuscous blotches, are present.

♀. 100—112 mm. Antennal pectinations 1. Wings without fuscous blotches, antemedian lines, and discal dots, uniformly suffused with reddish as far as postmedian lines; the apex of forewings not subfalcate; underside with discal dots present on both wings.

This species may be distinguished from *varia* by the whitish head and palpi, the ♀ also by the forewings not subfalcate at apex. Walker's ♂ is said to be from "between Sydney and Moreton Bay," the ♀ type simply from "Australia."

N. Qld.: Kuranda, near Cairns, in March (Dodd); one ♀.

40. Anthela canescens.

Darala canescens, Wlk., Cat. Brit. Mus., iv., p. 901.—*D. inornata*, Wlk., Cat. Brit. Mus., iv., p. 901.—*Dreata deficiens*, Wlk., Cat. Brit. Mus., xxxii., p. 374.—*Darala complens*, Swin., Cat. Oxf. Mus., i., p. 299.—*Anthela carneotincta*, Swin., Trans. Ent. Soc., 1903, p. 451.—*A. crenulata*, Swin., Trans. Ent. Soc., 1903, p. 451.—*A. epicrypha* Swin., Ann. Mag. Nat. Hist., (7), xvi., 1905., p. 150.

♂. 58—73 mm. ♀. 80—92 mm. Head yellow or pale-grey. Palpi 1¼; pale-grey. Antennae yellow; pectinations grey. Thorax and abdomen yellow or pale-grey. Legs grey; coxae and femora yellow. Forewings triangular, costa straight to ¾, thence gently arched, apex tolerably pointed, termen nearly straight, slightly oblique; yellow or pale-grey; fuscous (rarely reddish) discal dots at ⅓ and middle, the former sometimes obsolete; the latter larger; sometimes an irregularly dentate antemedian line, but usually none; occasionally a nearly straight postmedian line pale-fuscous or reddish edged with yellow, but usually none; sometimes a crenulate, fuscous, subterminal line, which may be reduced to dots on veins; cilia usually yellow, rarely pale-grey. Hindwings with termen gently rounded; 6 and 7 connate or stalked, 11 present; as forewings, but without discal dots. Underside similar, but with two discal dots on both winged, *not* pale-centred.

The ♂ exists in two colours, either yellow or pale-grey, the ♀ I have only seen of the latter colour. Grey specimens have the cilia usually yellow, rarely concolorous. The transverse lines may be strongly marked or wholly obsolete.

Vic.: Dimboola, Benalla; S. Aust.: Adelaide, Eudunda; W. Aust.: Perth, Carnarvon, Kalgoorlie.

41. Anthela repleta.

Darala repleta, Wlk., Cat. Brit. Mus., iv., p. 896.—*D. protocentra* Meyr., Trans. Roy. Soc. S. Aust., 1891, p. 191.—? *D. haemoptera* Low., Trans. Roy. Soc. S. Aust., 1893, p. 150.

♂. 45—55 mm. ♀. 56—76 mm. Head and palpi fuscous-brown. Antennae brown-whitish, pectinations fuscous-brown. Thorax, abdomen, and legs fuscous-brown. Forewings triangular, costa nearly straight, apex acute, slightly produced, termen strongly bowed, slightly oblique; brown, in ♂ often reddish brown, with more or less fuscous irroration; two discal spots beneath costa before and after middle, whitish in centre; a slender crenulate fuscous line from ⅔ costa to ⅔ dorsum, edged posteriorly by a pale line; a subterminal fuscous line or series of dots, edged posteriorly by a pale line; cilia brown, apices paler. Hindwings with termen slightly rounded, tornus somewhat produced; 6 and 7 connate or stalked, 11 feebly developed or absent; colour and markings as forewings, but without discal spots. Underside similar, but less distinctly marked; one or two discal dots on hindwings.

More dusky than *acuta*, from which it differs in the postmedian line of forewings being crenulate and not angled beneath costa; and the antennae not ochreous. It also resembles *nicothoe*, but is a smaller species with the apex

of the forewings more acute and slightly produced, and with the hindwings projecting at tornus.

Vic.: Moe, Wandin, Packenham, Gisborne, Fernshaw; Tas.: Launceston, Sheffield.

42. Anthela connexa.

♀. *Darala connexa* Wlk., Cat. Brit. Mus., iv., p. 898.—♂. *D. fervens* Wlk., Cat. Brit. Mus., iv., p. 898.—♂. *D. postica* Wlk., Cat. Brit. Mus., iv., p. 899.—♂. *Darala zonata* Feld., Reise Nov., Pl. 99, f. 1.

♂. 45—60 mm. Head ochreous-fuscous; face ochreous. Palpi 2; whitish-ochreous mixed with fuscous. Antennae fuscous, the stalk irrorated with whitish; pectinations 8. Thorax and abdomen ochreous-fuscous. Legs pale-ochreous. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, slightly oblique; orange-ochreous irrorated with fuscous; sometimes an obscure, irregularly dentate, transverse, fuscous line near base; a small white dot outlined with fuscous in disc at ⅓, another similar, but larger, in middle; a fuscous transverse line at ⅔, wavy, slightly curved outwards beneath costa; a terminal fuscous band, its anterior edge obscurely crenulate; cilia pale-ochreous, bases fuscous. Hindwings with termen moderately rounded; 6 and 7 connate, 11 absent or weak; orange-ochreous with some fuscous irroration; a transverse fuscous line about middle; preceded by a fuscous discal spot; a faint transverse fuscous crenulate line at ¾, sometimes reduced to a series of dots; a broad, terminal, dark-fuscous band, its inner edge crenulate; cilia orange-ochreous. Underside ochreous, each wing with two fuscous, white-centred discal dots, two postmedian fuscous lines, the second consisting of a series of dots, and a subterminal fuscous band.

♀. 62—74 mm. Antennae fuscous; pectinations 1. Both wings and underside brownish with fuscous irroration; costa of forewings sometimes irrorated with ochreous-whitish.

Postica is a ♂ aberration, similar to the normal form on underside, but above the orange colour on hindwing is confined to costal area.

Mr. Lyell informs me that the ♂ flies by day and, when on the wing, can easily be mistaken for a Satyrid butterfly.

Vic.: Wandin, Dandenong Ranges, Moe; Tas.: ——.

43. Anthela nicothoe.

Bombyx nicothoe Bdv., Voy. Astrolabe, Lep., 1832, p. 226.—*Darala adusta* Wlk., Cat. Brit. Mus., iv., p. 897.—*D. censors* (misprint) Wlk., *ib.*, xxxiii., p. 369, corrected to *consors*, *ib.*, xxxv., p. 1917.—*Laelia australasiae* H-Sch., Ausser. Schmet., f. 386.—*Colussa vinosa* Rosen., Ann. Mag. Nat. Hist., (5), xvi., 1885, p. 384.—*Darala rubeola* Feld., Reise Nov., Pl. 98, f. 9.

♂. 53—82 mm. Head, thorax, and abdomen reddish, ochreous, or brown. Palpi 1½; grey, reddish, or brown. Antennae whitish with some fuscous irroration; pectinations fuscous. Legs fuscous or grey; coxae and femora reddish, ochreous, or brown. Forewings triangular, costa straight to ⅔, then arched, apex round-pointed, termen slightly bowed, slightly oblique; reddish, ochreous, or brown, with transverse fuscous lines; discal dots white edged with fuscous, at ¼ and about middle; sometimes outwardly arched lines, more or less distinct, before and after first dot; a fine wavy or crenulate line at about ⅔, edged posteriorly by a pale line; a crenulate subterminal line, sometimes reduced to dots on veins; a crenulate submarginal shade; cilia concolorous. Hindwings with termen

slightly or moderately rounded; 6 and 7 connate, 11 present; as forewings, but without discal dots. Underside similar but with two discal dots on each wing, which may or may not be white centred.

♀. 72—104 mm. Wings grey; markings as in ♂, but postmedian line edged posteriorly by a brownish line.

Tasmanian ♂ examples are brown, those from the mainland are lighter and often ochreous or reddish; the ♀ varies little.

Vic.: Melbourne, Beaconsfield, Kewell; Tas.: Hobart; S. Aust.: Kangaroo Island.

Gen. 5. Chelepteryx.

Chelepteryx Gray, Trans. Ent. Soc., i., 1834., p. 122.

Palpi moderate, porrect, only slightly rough; terminal joint short. Antennae pectinated to apex in both sexes, pectinations shorter in ♀. Posterior tibiae with two pairs of spurs, which are placed rather near each other. Forewings with 4 and 5 separate, all veins from areole separate, subapical crossbar from 10 to 9 shortly beyond their bifurcation, and sometimes prolonged by a spur towards, but not reaching, 11. Hindwings with 3, 4, 5 separate, 6 and 7 approximated at base, 12 somewhat approximated to cell at ⅓ and connected with it by 11, which is strongly developed.

Type, *C. collesi* Gray. There are only two species, both of large size.

44. Chelepteryx collesi.

Chelepteryx collesi Gray, Trans. Ent. Soc., i., 1834, p. 122.—*Saturnia laplacei* Feist., Voy. de la Fav., v., 1839, Suppl., p. 20, Pl. 8, 9.

♂. 144—150 mm. Head brownish; upper half of face dark-fuscous. Palpi 2; dark-fuscous. Antennae brownish, pectinations dark-fuscous. Thorax brownish mixed with dark-fuscous. Abdomen brownish. Legs fuscous; coxae brown-whitish; anterior femora partly brown beneath. Forewings elongate-triangular, costa straight to beyond middle, thence arched, apex rectangular, termen strongly sinuate, strongly oblique; fuscous irrorated and suffused with brown, and, in costal area, towards base with whitish; with five dark-fuscous transverse lines; first from ⅓ costa, broadly suffused on costa and interrupted beneath costa, thence finer, sinuate, ending on dorsum beyond ⅓; second very irregularly dentate, inwardly oblique, obscure towards costa, from mid-costa joining first line on dorsum; third from ⅔ costa, obscure towards costa, thicker and wavy towards dorsum beyond middle; preceded by an obscurely outlined, subcostal, circular, brownish spot; fourth only defined in lower half, parallel to termen, acutely dentate, ending on ⅘ dorsum; fifth parallel and near to fourth, but broadly suffused, only developed towards dorsum, margined posteriorly by a pale line; the upper part of fifth line is replaced by three hyaline spots, placed obliquely, and rather suffusedly outlined; cilia short, concolorous. Hindwings with apex rectangular, termen only slightly rounded, tornus subrectangular; dark-fuscous; a suffused, median, transverse, brownish line; deeply crenated, ochreous, subterminal line, preceded by a series of small, linear, ochreous marks on veins; area beyond subterminal line irrorated with ochreous; cilia short, concolorous. Underside fuscous irrorated with whitish along costa and termen; a small white spot at end of cell; whitish postmedian and subterminal lines, and hyaline subapical spots; of hindwing, whitish irrorated with fuscous brown; a brownish wavy transverse line before middle, touching a circular, fuscous-

brown, discal spot with pale centre; pale postmedian and subterminal lines; veins fuscous shortly before postmedian, ochreous between lines.

♀. 168—177 mm. Similar, but paler in colour. Forewings with costa more evenly arched, termen not sinuate; fuscous lines less strongly marked and suffusedly bordered with whitish; hyaline spots of ♂ replaced by two, whitish, subapical spots placed obliquely.

Qld.: Mt. Tambourine, Toowoomba; N.S. Wales: Sydney; Vic.: Melbourne, Wandin, Gisborne.

45. Chelepteryx felderi.

Darala chalepteryx Feld., Reise Nov., Pl. 98, f. 10.—*Chelepteryx felderi* Turn., Trans. Ent. Soc., 1904, p. 481.

♂. 110—130 mm. Head grey-whitish, back of crown and lower ⅔ of face fuscous. Palpi 2½; fuscous-brown. Antennae grey-whitish, pectinations fuscous. Thorax and abdomen grey-brown. Legs grey-whitish; anterior pair fuscous; all coxae and undersurface of anterior femora reddish-brown. Forewings broadly triangular, costa slightly arched, apex pointed, termen sinuate beneath apex, thence bowed; oblique; pale brownish-grey irrorated with fuscous; basal area paler, limited by an oblique whitish line from midcosta to ⅓ dorsum; central area darker, more fuscous or brownish, its posterior edge from ¾ costa, at first outwardly curved, then parallel to first line, ending at ⅔ dorsum; two discal spots, first beneath ⅓ costa, second obliquely oval beneath midcosta, outlined with blackish, inside this a pale-brownish ring, centre fuscous; a paler postmedian band extending to apex; towards its posterior edge a series of dark-fuscous dots on veins; a darker terminal band in which a pale wavy subterminal line is sometimes visible; cilia short, concolorous. Hindwings with apex and tornus subrectangular, termen gently rounded, wavy; reddish, darker towards base; a dark-fuscous subcostal discal spot at ⅓; a suffused, nearly straight, dark-fuscous, transverse, median line; following this is a paler band containing, near its posterior edge, a fine fuscous line of fuscous dots on veins; a broad, dark-fuscous, subterminal line, with broad rectangular projections between veins posteriorly forming a castellated band; terminal area more or less suffused with fuscous; cilia short, concolorous. Underside reddish or ochreous-grey; a large, triangular, dark-fuscous, subcostal suffusion on forewings, containing whitish orbicular and reniform spots; hindwings with small whitish discal spots, outlined with fuscous at ⅓ and ½; a whitish, sinuate, wavy, transverse median line; a series of fuscous dots on veins at ¾; a very obscure, castellated, subterminal band.

♀. 110—140 mm. Similar, but paler and markings much more obscure. Forewings with discal spots distinctly or obscurely outlined, not dark-centred. Hindwings reddish, or grey with reddish suffusion only towards base; no discal spot; castellated band obscurely indicated. Underside of forewings without dark-fuscous suffusion; discal spots present in both wings.

N. Qld.: Atherton; Qld.: Gympie, Brisbane, Mt. Tambourine; N.S. Wales: Sydney, Katoomba; Vic.: Wandin.

Gen. 6. Gephyroneura.*

Gephyroneura Turn., Trans. Ent. Soc., 1919, p. 417.

Tongue absent. Palpi 1, porrect; second joint with dense long hairs beneath; terminal joint concealed. Antennae bipectinated to apex. Legs densely

* γεφυρονευρος, with bridged veins.

hairy; posterior tibiae with middle spurs absent, terminal spurs minute. Forewings with 4 and 5 separate, 6 short-stalked, 7, 8, 9, 10 long-stalked from cell, about halfway between cell and apex 10 diverges, and by the subapical cross-bar, which runs from 11 to 9, a small triangular areole is formed, from which all four veins arise separately. Hindwings long, rhombiform, 3, 4, 5 separate, 6 and 7 stalked, 12 anastomosing with cell at a point before middle.

I have figured and attempted to explain the extraordinary neuration of the forewing (Trans. Ent. Soc, 1919.).

The anastomosis of 12 of hindwings with the cell represents a shortening of the persistent vein 11. The genus is a derivative of *Munichryia* with considerable modification.

46. Gephyroneura cosmia,† n.sp.

♂. 24—28 mm. Head and thorax grey with some whitish hairs. Palpi fuscous. Antennae whitish; pectinations fuscous. Abdomen brownish. Legs whitish; anterior pair fuscous with some whitish hairs; all tarsi fuscous with whitish annulations. Forewings triangular, costa straight, apex pointed, termen nearly straight, slightly oblique; whitish with fuscous irroration and markings, so as to appear mostly grey; a slightly waved line from ¼ costa to mid-dorsum; a small, median, subcostal discal mark; a rather faint line, strongly bisinuate, from ⅔ costa to ⅔ dorsum; a more distinct, irregularly crenated, subterminal line, edged posteriorly with whitish; an interrupted terminal line; cilia whitish, on tornus mixed with fuscous. Hindwings rhombiform with a rounded prominence on vein 3; pale-grey; a faintly darker, wavy, subterminal line; some whitish irroration towards termen; cilia grey mixed with whitish. Underside grey with darker discal dot and broad subterminal band on both wings.

In facies this resembles *M. senicula* Wlk.

N. Qld.: Evelyn Scrub, near Herberton, in December and January; two specimens received from Mr. F. P. Dodd.

Gen. 7. Munichryia.

Munichryia Wlk., Cat. Brit. Mus., xxxii., p. 395.

Tongue strongly developed. Palpi 2, porrect; second joint with long dense hairs beneath; terminal joint concealed. Antennae bipectinated to apex in both sexes, but pectinations in ♀ very short (1). Legs densely hairy; posterior tibiae with two pairs of short spurs. Forewings with 4 and 5 separate, areole long, subapical cross-bar extending from 11 to 10 and 9, sometimes fusing with basal part of 9, all veins arising separately from areole. Hindwings long, rhombiform; 3, 4, 5 separate, 6 and 7 connate or short-stalked, 12 somewhat approximated to cell before middle, and connected with it by 11 which is short, but well developed.

In a ♂ example, the subapical crossbar is fused with that part of the areole formed by the base of vein 9 as figured by me (Trans. Ent. Soc., 1919, p. 418), but in another ♂ and a ♀ I find 9 diverging from 10 before the areole, so that in these examples the structure of the areole is that normal in the family.

Type, *M. senicula* Wlk.

47. Munichryia senicula.

Munichryia senicula Wlk., Cat. Brit. Mus., xxxii., p. 396.—*Hypochroma nyssiata* Feld., Reise Nov., Pl. 125, f. 3.

♂. 30—32 mm. Head, palpi, and thorax grey. Antennae whitish with a few dark-fuscous scales; pectinations fuscous. Abdomen grey or whitish-grey.

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†κοσμιος, neat.

Legs whitish-grey; tarsi dark fuscous annulated with whitish. Forewings triangular, costa nearly straight, slightly sinuate, apex acute, termen slightly sinuate beneath apex, thence bowed, slightly oblique; grey mixed with whitish; markings fuscous; an irregularly dentate line from $\frac{1}{4}$ costa, bent inwards from middle to fold, abruptly outwardly on fold, ending on mid-dorsum; a small, transverse, median, blackish, discal mark; a faint oblique line from $\frac{3}{4}$ costa, bisinuate to $\frac{3}{4}$ dorsum; a more distinct, irregularly dentate, subterminal line, bidentate inwards above dorsum; an interrupted terminal line; cilia whitish-grey. Hindwings rhombiform with a rounded prominence on vein 3; whitish; a fuscous dot before middle; a large terminal fuscous suffusion with some whitish irroration near termen; cilia whitish-grey. Underside whitish with large terminal fuscous suffusions, that on hindwing darker and not reaching margin.

♀. 37 mm. Markings much less distinct; on forewings only discal dot, postmedian, and terminal lines are traceable.

N.S. Wales: Sydney in April and July; Vic.: ——; W. Aust.: Cunderdin in October (♀, R. Illidge). Walker's type is said to be from Moreton Bay.

Species unrecognised or wrongly referred to the family.

48. *Arnissa simplex* Wlk., Char. Undesc. Lep., p. 77. I examined the type in the National Museum, Melbourne, some years ago, and recognised it as belonging to the genus *Anthela*, but was not able to determine the species.
49. *Darala lineosa* Wlk., Trans. Ent. Soc., (3), i., 1862, p. 269. I have seen the type in the Oxford Museum. It has been removed to the *Eupterotidae* and bears an MS. label "Not Australia but Delagoa Bay." I do not doubt that it is not Australian.
50. *Chenuala rufa* Swin., Cat. Oxf. Mus., i., p. 212. It is doubtful whether this belongs to the *Anthelidae*, and whether it is really Australian.
51. *Darala expansa* Luc., Proc. Linn. Soc. N.S. Wales, 1891, p. 286, belongs to the genus *Eupterote* (*Eupterotidae*).
52. *Darala linearis* Luc., Proc. Linn. Soc. N.S. Wales, 1891, p. 289.
53. *Darala rubriscripta* Luc., *ib.*, p. 291.
54. *Darala rosea* Luc., *ib.*, p. 291.
55. *Darala cupreotincta* Luc., Proc. Roy. Soc. Q'land., 1891, p. 75.
56. *Darala serranotata* Luc., Proc. Linn. Soc. N.S. Wales, 1893, p. 138, belongs to the genus *Cotana* (*Eupterotidae*).
57. *Darala trisecta* Luc., Proc. Roy. Soc. Q'land., 1898, p. 67.
58. *Darala maculosa* Luc., *ib.*, p. 67.
59. *Darala consuta* Luc., Proc. Roy. Soc. Q'land., 1899, p. 139.

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Index to Species.

Synonyms and unrecognised species in italics.

REVISIONAL NOTES ON AUSTRALIAN *CARABIDAE.*

PART vi. Tribe BEMBIDIINI.

By THOMAS G. SLOANE.

The position of the tribe Bembidiini in the family *Carabidae* is after the tribe Merizodini, beside the Trechini; it may be defined briefly, but sufficiently, as follows:—

Anterior coxal cavities with a single opening inwards. Head with two supraorbital setae on each side; mandibles with a seta in scrobe of outer side; antennae with not more than two basal joints glabrous. Palpi subulate, maxillary with penultimate joint pubescent. Elytra with margin interrupted posteriorly by an internal plica.*

Table of Australian Genera.

1	(4)	Elytra with a scutellar striole at base of first interstice. Anterior tibiae not oblique at apex.
2	(3)	Clypeus decidedly obliquely narrowed to apex. Elytra with striae punctate, fifth stria not uniting with marginal channel at base .. BEMBIDION.
3	(2)	Clypeus wide, hardly narrowed to apex. Elytra with fifth stria extending in full depth to base and uniting with marginal channel. CILLENUS
4	(1)	Elytra without a scutellar striole. Anterior tibiae oblique above apex on external side.
5	(8)	Eyes present.
6	(7)	Upper surface glabrous, except for the usual fixed hairs.† .. TACHYS
7	(6)	Upper surface setulose. Eyes small; distant from buccal fissure beneath .. .. LIMNASTIS
8	(5)	Eyes wanting .. .. ILLAPHANUS

Genus BEMBIDION.

Latreille, Hist. Nat. Ins., iii., 1802, p. 82.

Latreille's name *Bembidion* was by later authors latinised to *Bembidium*, and in the Munich Catalogue of 1867 was emended to *Bembicidium;* recent opinion favours a return to Latreille's original name. In the Catalogus Coleop-

*In *Tachys macleayi* Sl., the internal plica is practically obsolete.

†Dr. Walther Horn has proposed the term "fixed" for those setae and hairs usually designated "tactile" or "sensitive" hairs; the term "fixed" appears to me the best, and is used throughout this paper (*Cf.* Horn W., in Wytsman's Gen. Ins., Fasc. 82c, *Cicindelinae*, 1915, p. 212.)

terorum Europae (1906) 23 subgeneric names are recognised among the 174 species there recorded, of which only *Philocthus* appears in our fauna; Netolitzky in 1914 proposed a subgenus *Notaphocampa* founded on *B. niloticum* Dej., into which *B. opulentum* Niet. will come.*

Blackburn published a table including all the Australian species (Trans. Roy. Soc. S. Aust., 1901, p. 122), which is merely an aid in the identification of the species; I therefore venture to offer the following table to indicate the natural groups among our species.

Table of Australian species known to me.

1	(4)	Frontal sulci shallow, not crossing clypeus, interspace depressed.
2	(3)	Prothorax cordate, sides sinuate posteriorly, lateral margin narrow, base a little arcuate, lightly oblique on each side .. .. .. *opulentum* Niet.
3	(2)	Prothorax transverse, rounded on sides, lateral margin wide, base shortly sublobate, strongly sinuate on each side .. .. .. *jacksoniense* Guer.
4	(1)	Frontal sulci deep, crossing clypeus, interspace convex.
5	(6)	Elytra with third and fifth interstices bearing fixed setae .. .. *proprium* Blackb.
6	(5)	Elytra with discal fixed setae only on third interstice.
7	(8)	Elytra with seven inner striae present .. .. *dubium* Blackb.
8	(7)	Elytra with six inner striae present .. .. *errans* Blackb.

B. hobarti Blackb. (Tasmania) and *B. wattsense* Blackb. (from the Watts River, a tributary of the Yarra) are unknown to me in nature; both are evidently species distinct from one another and from all our other species. *B. hobarti* has the seventh stria perceptible; it may be allied either to *B. proprium* or *B. dubium*, though it is not likely to have fixed setae on the fifth interstice. *B. wattsense*, having only the five inner striae marked, is thus differentiated from all the other Australian species known.

Bembidion opulentum Nietner.

Ann. Mag. Nat. Hist., (3), ii., 1858, p. 420; Andrewes, Ann. Mag. Nat. Hist., (9), iii., 1919, p. 472; Sloane, Proc. Linn. Soc. N.S. Wales, xlv., 1920, p. 321.—*B. europs*, Bates, Ann. Mag. Nat. Hist., (5), xvii., 1886, p. 156.—*B. riverinae*, Sloane, Proc. Linn. Soc. N.S. Wales, (2), ix., 1894, p. 405.

I believe the synonymy given above to be correct; probably *B. hamiferum* Fauvel (1882) from New Caledonia will prove to be the same species.

Hab.—Australia, Sumbawa, Java, Ceylon, India. Beside fresh water.

Note.—It has been found in Queensland, New South Wales, and Victoria, but I have not seen it from South Australia or Western Australia.

Bembidion jacksoniense Guérin.

Voy. Coquille, 1830, p. 61, Pl. i., fig. 17; Sloane, Proc. Linn. Soc. N.S. Wales, (2), ix., 1894, p. 406.—*Bembidium subviride*, Macleay, Trans. Ent. Soc. N.S. Wales, ii., 1871, p. 118.—*B. ocellatum*, Blackburn, Trans. Roy. Soc. S. Aust., x., 1886-87 (1888), p. 44; Proc. Linn. Soc. N.S. Wales, (2), vii., 1892, p. 98.

This species seems to be found over the whole continent of Australia beside fresh water.

*I have not seen any of the numerous memoirs on the tribe Bembidiini published by Dr. Netolitzky in recent years.

BEMBIDION PROPRIUM Blackburn (1887).*

In his description of this species Blackburn has mentioned the long sparse setae of the elytra; these are on the third (two setae) and fifth interstices (about four setae), as in some species from New Zealand.

I have only taken one specimen, beside a little rivulet near where it entered the sea; I have not seen it from an inland locality.

Hab.—South Australia: Port Lincoln (Blackburn); Victoria: Melbourne, Lakes Entrance (Wilson); N.S. Wales: Wollongong (Sloane).

BEMBIDION DUBIUM Blackburn (1887).

Hab.—South Australia: Port Lincoln and Bank of Murray (Blackburn); Victoria: Serviceton and Yea (Sloane); New South Wales: Mulwala (Sloane), Delegate (from Mr. H. J. Carter, ticketed "attracted to light"). Beside fresh water.

BEMBIDION ERRANS Blackburn (1887).

Blackburn says of this species, "probably occurring only near the coast"; I have not seen it from an inland locality. I found it in Western Australia on the muddy margin of the Vasse River within the tidal influence.

Hab.—South Australia: Port Lincoln, Adelaide, mouth of the Murray River (Blackburn); Victoria: Melbourne (Fischer).

Genus CILLENUS.

Cillenus Samonelle (1819) is older than *Cillenum* Curtis (1829) which has also been used.

The genus is widely spread on sea beaches, having been reported from Europe (England to the shores of the Mediterranean), New Guinea, Australia (east coast), and New Zealand. Our two species differ, *inter alia* from *C. lateralis* Sam., by elytra more strongly striate, third interstice 2-punctate, not 4 punctate, basal part of the lateral furrow which passes round the shoulders deeper.

CILLENUS MASTERSI Sloane.

Hab.—Sydney; Tasmanian shore of Bass Straits (Ilfracombe, Simson).

CILLENUS ALBOVIRENS Sloane.

Differs from *C. mastersi* Sl., by prothorax much more narrowed to base and more strongly rounded on sides; elytra more oval, more strongly shagreened, etc.

Hab.—Queensland: Cairns (Dodd).

Genus TACHYS.

Stephens, Ill. Brit. Ent., ii., 1828, p. 2.

The full synonymy of the genus *Tachys* is not given here, but a list of those names to which generic or subgeneric rank has been attributed by different authors is subjoined, in each case followed by the name of the author, year of publication, and the name of an Australian representative species:—

*In this paper references are given only where the synonymy of a species requires to be stated, in other cases the date is given so that the species may be found readily in zoological literature.

Tachyta Kirby, 1837 (*T. brunnipennis* Macl.); *Elaphropus* Motschulsky, 1839 (*T. bifoveatus* Macl.); *Tachylopha* Motschulsky, 1862 (*T. spenceri* Sl.); *Tachyura* Motschulsky, 1862 (*T. curticollis* Sl.)*; *Polyderis* Motschulsky, 1862 (*T. captus* Blackb.)

I give below some notes on characters which vary in the genus *Tachys.*

Antennae.—There is considerable difference in the length of the antennae owing to differences in the form of the joints; *T. macleayi* Sl., shows the longest antennae with the longest joints, and *T. captus* Blackb., one of the shortest with moniliform joints. The relative length of the second and third joints varies, in *T. murrumbidgensis* Sl., the second joint is shorter than the third, in *T. macleayi* longer; the longer second joint seems a recent character.

Frontal sulci.—The front is always bi-impressed; two chief forms of the sulci may be noted, viz., (1) short, not extending on to the clypeus, and (2) elongate, extending across the clypeus; the elongate sulci, in traversing the clypeus, isolate the fixed seta on each side. The short form of the sulci is the ordinary one, and evidently the most ancient, but the single character of a similarity in the form of the frontal sulci does not in itself show near relationship between species.

Prothorax.—The prothorax shows many variations in shape; it may be convex, or depressed, it may have the base wide with sharply rectangular angles, the sides parallel posteriorly (*T. ectromioides* Sl.), or the base narrow, the sides strongly rounded and sinuate before the base (*T. monochrous* Schm.); and there are many other variations in shape. The base is always more or less produced backward in the middle, the degree of prominence varying considerably. The posterior angles vary a good deal. A transverse sulcus across the base, defining a median basal area, is almost always present, but is wanting in *T. spenceri* Sl., and *T. iaspideus* Sl.; it is generally more or less punctate, simple in *T. lindi* Blackb., and 5-foveate in *T. convexus* Macl., and in the Oriental species *T. interpunctatus* Putz. Some species have a short longitudinal submarginal carina near each basal angle, but this character does not seem in itself of much use in showing relationships between species.

Elytra.—The striation may vary from fully striate (*i.e.*, 9-striate) as in *T. amplipennis* Macl. to laevigate (without striae) as in *T. macleayi;* in species with less than nine striae any number from eight (seventh obsolete), as in *T. monochrous*, to one, as in *T. bifoveatus* Macl., may occur; the outer stria is successively lost as the number becomes less, with the result that the first is the most persistent. The varying forms of the eighth stria and ninth interstice are of high taxonomic value; the eighth stria may be deep, simple, and entire, with the ninth interstice convex, or entire with the ninth interstice depressed, or it may consist of a row of punctures along the side, or it may be obsolete on the side though well marked towards the apex, or it may be altogether obsolete. A striole (apical striole) is present in nearly all species of *Tachys* on the apical declivity of each elytron; it is sometimes near the margin, in about the position of the normal seventh stria, though usually it is about the middle line of the elytra. The apical striole is evidently derived from the apical part of the seventh stria, and the interval between it and the eighth stria is

*Bates, after 1881, habitually used the subgeneric term *Barytachys* (which he attributed to Chaudoir) for *Tachys klugi* Nietner, and many allied species (*T. bipustulus* Macl., is an allied Australian species) but I have not been able to trace the name *Barytachys* in the literature available to me, nor to find out in what way it differs from *Tachyura.*

homologous with the seventh interstice which occurs throughout the tribe Merizodini, and in *Amblytelus* and some other genera of the Pterostichini, and also in the tribe Bembidiini in the genus *Ocys*. It is probable that *T. amplipennis* and *T. nervosus* Sl., belong to a stem in which apical strioles were wanting, but that *T. yarrensis* Blackb., *T. australicus* Sl., and *T. captus* Blackb., are descended from species which had these strioles developed. The fixed setiferous pores or punctures of the elytra have considerable taxonomic value; they may occur on the third, fifth, seventh, and ninth interstices.* The setiferous punctures of the ninth interstice are always present, but no use is made of them here. On the inner side of the apical striole, well back from its anterior extremity, in those species with two discal setiferous punctures, a puncture may be seen which is homologous with the setiferous puncture or punctures so often found in the *Carabidae* near the apex of the seventh interstice (*e.g.*, tribes Merizodini and Pterostichini); the homologies of this fixed apical puncture of the seventh interstice can be made out best in *T. amplipennis*, where, there being no apical striole, it can be seen on the inner side of the eighth stria. Setiferous punctures occur on the fifth interstice in *T. interpunctatus* Putz., and in an undescribed species allied to *T. ovatus* Motsch., which has been sent to me by Mr. H. E. Andrewes ticketed "Nilgiri Hills." The fixed setiferous punctures of the disc are of recognised value in the classification of the species of *Tachys*; in many species there are two discal punctures, in others only one. Generally when there are two discal punctures they are on, or at the position of, the third interstice; when they are so placed there never seems to be a third puncture, but sometimes (*T. bifoveatus* Macl., and extra-Australian allied species) only the posterior discal puncture (non-setiferous) remains on, or at, the position of the third stria. Some species (*e.g.*, *T. murrumbidgensis*) have two discal punctures on the fourth interstice and a third one, high up on the apical declivity, on the third interstice. In species with one discal puncture, forward on the elytra, it may be on the third, fourth, fifth or sixth interstice, and, in all these cases, there is a second setiferous puncture high up on the apical declivity, either inside the anterior extremity of the apical striole, or before its extremity; this setiferous puncture of the apical declivity is evidently homologous with the third puncture of *T. murrumbidgensis* and not with the puncture mentioned above as occurring beside the apical striole far back from its extremity, which is also present in *T. murrumbidgensis*. The single setiferous puncture before the middle, whether it occurs on the third, fourth, fifth, or sixth interstice must be considered to be the same thing, its original position having been on the third interstice, whence it has shifted to as far out as the sixth; evidences of this may be seen in a slight irregularity of the sculpture of the elytra beside the puncture inwardly in *T. triangularis* Niet., in which it is on the fourth interstice, and in Oriental species in my collection where it is on the fifth interstice; in other Oriental species in

** T. interpunctatus* Putz., from Celebes, has the elytra between the first and ninth interstices (this last convex) sparsely setigero-punctate; the punctures are strong and are disposed in rows on or at the position of interstices 2—8. It seems probable that setosity of the upper surface was a character of the primitive Bembidiini. It occurs to a marked degree in the present-day genera *Limnastis* and *Asaphidion*. It may be noted that some species of *Tachys* (e.g. *T. brunnipennis* Macl. and *T. murrumbidgensis* have the upper surface punctulate, and, though the punctures are no longer setiferous, we may suppose such species to have descended from ancestors in which setae were present.

which it is on the sixth interstice a similar irregularity occurs, though in these species the third stria and interstice are regular.

Tarsi.—In *Tachys* the posterior tarsi are generally elongate and slender, but are short and stout in *T. murrumbidgensis*. The length of the first joint varies from longer than the three succeeding joints together, to shorter than the two succeeding joints together. Some use has been made of the differences in length of the posterior tarsi, but I have not given sufficient attention to the question of the variations of the posterior tarsi in the genus *Tachys* to enable me to speak confidently regarding the taxonomic value of such differences as I have observed; attention may be drawn to the relatively short posterior tarsi of *T. ovensensis* Blackb., in comparison with the elongate ones of *T. striolatus* Macl.

Colour.—The colours in the tribe Bembidiini are very variable; as a rule sombre colours must be looked upon as more primitive than bright colours, or lively patterns. Joints 7—11 of the antennae are pallid in *Tachys macleayi* and *T. ovatus*, species not at all nearly related to one another. A similar paleness of some of the joints of the antennae occurs in many species of the tribe Odacanthini, especially those of South America, also in the Australian genus *Homothes* of the tribe Anchomenini (*H. elegans* Newm., joints 7 and 8, *H. velutinus* Macl., joints 7—10 pallid). Somewhat similar spots on the elytra to those which occur in many species of *Tachys* are found in the tribe Odacanthini. I would note here that these pallid joints of the antennae and pale spots of the elytra in the tribe Odacanthini are more ancient than the present-day genera, and probably have considerable taxonomic value; they seem to be "recognition"— or "warning"—marks.

Table of Australian Species.

1 (28) Elytra with ninth interstice convex; eighth stria strongly impressed; two setiferous punctures on disc, on or at position of third interstice.

2 (5) Elytra without apical striole. (Prothorax with a submarginal carina. Colour brownish testaceous.)

3 (4) Elytra 9-striate; interstices ordinary, convex. 3.3 mm., *amplipennis* Macl.

4 (3) Elytra 17-striate; eight inner striae duplicated. 3.3 mm., *nervosus* Sl.

5 (2) Elytra with distinct apical striole, a distinct puncture beside inner margin of apical striole far back.

6 (25) Prothorax with a transverse basal impression. Elytra with border not prominent behind humeral angles; lateral channel passing round humeral angles.

7 (24) Frontal sulci short, wide apart, not extending on to clypeus.

8 (23) Prothorax with posterior angles not forming a prominent tubercle.

9 (16) Prothorax with base wide, truncate on each side; lateral basal impressions distant and separated from lateral margin by a wide depressed space.

10 (13) Elytra with fifth stria uniting with marginal channel at base; 4-maculate.

11 (12) Elytra with all striae indicated, seventh short, only impressed in middle; humeral macula extending from fifth stria to margin. 2.8 mm. .. .. *banksi* Sl.

12 (11) Elytra 6-striate (seventh stria obsolete); humeral macula on interstices 7 and 8, not reaching base. 3.1 mm. .. .. .. *buprestioides* Sl.

13 (10) Elytra with fifth stria not reaching base; 2-maculate.

14 (15) Elytra 6-striate. 2.2—2.6 mm. .. .. *bipustulatus* Macl.

15 (14) Elytra 5-striate. 2.9 mm. .. .. *solidus* Sl.

16 (9) Prothorax angustate posteriorly; base not or hardly wider than apex; lateral basal impressions deep, concave, narrowly divided from lateral margin by a convex interspace.

17 (20) Elytra with more than two striae.
18 (19) Elytra 6-striate, 2-maculate. 3 mm. .. .. *helmsi* Sl.
19 (18) Elytra 5-striate, 4-maculate. 2.8 mm. .. .. *striolatus* Macl.
20 (17) Elytra 2-striate.
21 (22) Black, elytra with two red maculae. 2.9—3.1 mm. *ovensensis* Blackb.
22 (21) Brown, elytra with four testaceous maculae. 2.5 mm. *flavicornis* Sl.
23 (8) Prothorax with an ante-basal triangular tubercle marking posterior angles. (Elytra 1-striate, 4-maculate). 2.3—2.8 .. .. *convexus*. Macl.
24 (7) Frontal sulci elongate, deep, converging and crossing clypeus. (Elytra 1-striate, 4-maculate). 2 mm. .. .. *curticollis* Sl.
25 (6) Prothorax without a transverse basal impression. Elytra with border subprominent just behind shoulders; lateral channel obsolescent on base.
26 (27) Prothorax with basal angles marked by a little tubercle. Elytra 2-striate. 2.5—2.7 mm. .. .. *spenceri* Sl.
27 (26) Prothorax with basal angles not tuberculate. Elytra 1-striate. 2.8 mm. *inspideus* Sl.
28 (1) Elytra with ninth interstice depressed, often not indicated on middle of sides; eighth stria entire, or represented by a row of punctures along sides, or obsolete at least in middle.
29 (68) Elytra with two fixed punctures on disc [in *T. bifoveatus* Macl., and extra-Australian allied species only the posterior (non-setiferous) puncture present], and a puncture on inner side of apical striole (if present) far back.
30 (39) Upper surface of head and prothorax (also elytra, except in *T. wilsoni* Sl.) more or less punctulate. Anterior discal puncture of elytra outside third interstice. Posterior tarsi short.
31 (32) Prothorax transverse, wide across base, with a submarginal basal carina. Elytra with eighth stria entire; two setiferous punctures on fourth interstice, anterior at basal sixth, posterior just before apical declivity. 2.5—2.8 mm. .. .. *brunnipennis* Macl.
32 (31) Prothorax subcordate, angustate to base, no submarginal basal carina. Elytra with eighth stria obsolete on sides; three setiferous punctures (two discal) anterior on or at position of fourth interstice, posterior high up on apical declivity; an abbreviated fifth stria present towards base.
33 (38) Form narrow, depressed (more than twice as long as broad). Frontal sulci long, deep, parallel. Elytra minutely punctate, at least four inner striae marked.
34 (37) Head not narrowed behind eyes; eyes of ordinary size.
35 (36) Brown. Prothorax distinctly shagreened and punctate. 1.75—2.4 mm. *murrumbidgensis* Sl.
36 (35) Black. Prothorax nitid, puncturation very faint and microscopic. 2.4 mm. .. .. *leai* Sl.
37 (34) Head obliquely narrowed behind eyes; eyes small and distant from buccal fissure beneath. Testaceous. 2 mm. .. .. .. *obliquiceps* Sl.
38 (33) Form stout, convex (about twice as long as broad). Frontal sulci short, shallow. Elytra impunctate, first stria, and fifth near base marked. 2 mm. .. .. *wilsoni* Sl.
39 (30) Upper surface impunctate (excepting for fixed setiferous punctures).
40 (65) Elytra with a well developed apical striole and a puncture beside inner side of this striole far back.
41 (58) Elytra with eighth stria indicated on sides, and extending forward at least as far as anterior punctures of ninth interstice.
42 (47) Prothorax with a submarginal carina.
43 (44) Prothorax very wide across base, parallel on sides. Elytra depressed on disc. Bicoloured. 3 mm. .. .. *ectromioides* Sl.
44 (43) Prothorax evidently narrowed to base; sides oblique posteriorly. Elytra convex, black
45 (46) Elytra bistriate, eighth stria strongly impressed on sides. 2.6 mm. *atridermis* Sl.

46 (45) Elytra lightly bistriate, eighth stria obsolete on middle of sides. 2 mm. *carinulatus* Sl.
47 (42) Prothorax without a submarginal carina. Eighth stria punctate on sides.
48 (53) Prothorax strongly sinuate posteriorly; basal area greatly depressed below plane of pronotum and defined by a strong sulcus. Species of reddish colour.
49 (50) Elytra 6-striate. 2.6 mm. .. .. *monochrous* Schm.
50 (49) Elytra 5-striate.
51 (52) Prothorax with border forming the narrow margin of the deep basal fovea; lateral margin with several setae near apex. 2.6 mm. *seticollis* Sl.
52 (51) Prothorax with space between end of transverse basal sulcus and lateral margin triangular, lateral border not forming margin of the basal impression. 2—2.3 mm.. .. ..*flindersi* Blackb.
53 (48) Prothorax shortly sinuate posteriorly; basal area not decidedly below plane of pronotum in middle; transverse basal sulcus more or less interrupted, at least in middle.
54 (55) Prothorax with lateral border obsolete; sides very rotundate, and greatly narrowed to base. 2—2.3 mm. .. .. .. *semistriatus* Blackb.
55 (54) Prothorax with lateral border ordinary. Black species.
56 (57) Elytra 6-striate. 2—2.2 mm. .. .. *habitans* Sl.
57 (56) Elytra 5-striate. 2.2 mm. .. .. *olliffi* Sl.
58 (41) Elytra with eighth stria obsolete, at least on middle of sides.
59 (60) Frontal sulci deep, long, convergent, crossing clypeus. 6-striate. 2 mm. *mitchelli* Sl.
60 (59) Frontal sulci not crossing clypeus.
61 (64) Prothorax transverse; base much wider than apex; lateral basal impressions distant from basal angles.
62 (63) Form ovate. Elytra depressed; disc with two fixed setiferous punctures, 3-striate. 2.5—3 mm. .. .. *mulwalensis* Sl.
63 (64) Form short, oval, very convex. Elytra with one non-setiferous puncture behind middle. 1-striate. 2—2.2 mm. .. .. *bifoveatus* Macl.
64 (61) Prothorax cordate, base and apex about equal in width. Black; elytra 2-striate. 2 mm. .. .. *blackburni* Sl.
65 (40) Elytra with apical striole obsolescent.
66 (67) Form convex. 1.7 mm. .. .. *australicus* Sl.
67 (66) Form depressed. 1.5 mm. .. .. *captus* Blackb.
68 (29) Elytra with one fixed setiferous puncture on disc before middle and a setiferous puncture high up on apical declivity.
69 (90) Elytra striate.
70 (71) Elytra fully striate; apical striole obsolete. 2—2.3 mm *yarrensis* Blackb.
71 (70) Elytra never fully striate; apical striole distinct.
72 (85) Elytra with fixed, setiferous, discal puncture on or at position of third interstice.
73 (84) Elytra with apical striole elongate, extending past fixed setiferous puncture of apical declivity.
74 (77) Elytra ovate, 4-maculate.
75 (76) Head, prothorax and dark parts of elytra black. 2.7—3 mm. *doddi* Sl.
76 (75) Head and dark parts of elytra reddish piceous, prothorax reddish. 2—2.5 mm. .. .. *lindi* Blackb.
77 (74) Elytra narrow, parallel.
78 (79) Piceous, 2—2.3 mm. .. .. *uniformis* Blackb.
79 (78) Not wholly piceous.
80 (83) Head and prothorax piceous.
81 (82) Elytra piceous with a wide testaceous vitta on each side (the vitta sometimes interrupted in the middle). 2.3—2.7 mm. *queenslandicus* Sl.
82 (81) Elytra testaceous with indeterminate infuscation. 2.5 mm. *infuscatus* Blackb.

83 (80) Prothorax reddish testaceous. 2.7 mm. .. .. *similis* Blackb.
84 (73) Elytra with apical striole short, not extending forward to setiferous puncture of apical declivity. 1.8—2.1 mm. .. .. *sinuaticollis* Sl.
85 (72) Elytra with fixed setiferous discal puncture outside third interstice or its position.
86 (87) Elytra with the fixed, setiferous, discal puncture on fourth interstice. Testaceous; head, apex, and a median fascia piceous. 2.3—2.5 mm. *triangularis* Niet.
87 (86) Elytra with the fixed setiferous discal puncture outside fourth stria or its position.
88 (89) Size major, form robust, elytra wide, oval, convex. 2.8 mm. *mastersi* Sl.
89 (88) Size minor, form depressed. 2.3—2.6 mm .. .. . *transversicollis* Macl.
90 (69) Elytra laevigate (apical striole obsolete), 4 maculate. 2.6—2.8 mm. *macleayi* Sl.

Tachys amplipennis Macleay (1871).

A good many specimens were obtained on a sand-bank of the Upper Normanby River, near Cooktown, in June; these were dislodged from their hiding places in the sand by splashing water from the river.

Tachys victoriensis Blackburn (1891)

Very nearly allied to *T. amplipennis*. It is unknown to me in nature; the following note, dated 16-3-1903, was sent to me by the late Rev. Thos. Blackburn, after I had sent him a specimen of *T. amplipennis*. "'Compared with specimen sent as *T. amplipennis*—very close, disc much darker (in strong contrast to shoulders and apex); joints 5—11 of antennae quite dark fuscous in contrast to basal joints. Prothorax less transverse, more narrowed in front and with the greatest width more distinctly in front of the middle. I think the two are distinct; at any rate *T. victoriensis* is a well marked mountain race, even if subsequent investigation produces intermediate forms from other places."

Tachys nervosus Sloane (1903).

In July, 1916, I found *T. nervosus* plentiful on the sandy bed of the Laura River at the terminus of the Cooktown—Laura railway. It was a very noticeable species, from its pale-coloured, widely spread legs in contrast with the darker colour of the upper surface of the body, which is sometimes almost brown on the disc of the elytra, as it ran quickly over the sand before taking to the wing, when disturbed by the splashing of water over the sand. The additional striae, which have been developed on interstices 1—8 of the elytra, are deepest on the disc; one specimen, with the extra striae less strongly impressed than usual, shows, at the apex, practically the same striae and interstices as *T. amplipennis* Macl.

Tachys banksi, n.sp.

Robust, oval, convex. Front shortly bi-impressed. Prothorax transverse, wider across base than apex; basal angles rectangular; a punctate line across middle of base. Elytra ovate, fully striate; seventh stria very short, situated between humeral and apical maculae, fifth stria reaching marginal channel at base, eighth stria entire, deep, simple; ninth interstice convex; disc bipunctate on third interstice; a puncture on inner side of apical striole, far back. Piceous; pronotum of a bronzy tint; elytra 4-maculate, humeral macula rather elongate, extending from fifth stria to margin at base, apical macula between third and eighth striae, apex lurid-testaceous. Length, 2.8, breadth, 1.2 mm.

Hab.—Queensland. I found two specimens on the margin of the Normanby River at Kings Plains cattle station.

The striation is as follows: 1 entire, 2—4 reaching nearly to base, 6 and 7 abbreviated basad, 3—7 successively shorter distad, and not extending on to apical macula. Allied to *T. buprestioides* Sl., but differing by size smaller; prothorax with sides more rounded, more narrowed to base, juxta-basal sinuosity a little stronger, anterior angles less marked; elytra with seventh stria well developed on the piceous space between the maculae, humeral macula spreading over fifth and eighth interstices at base, apical macula extending inwards to third stria.

TACHYS BIPUSTULATUS Macleay.

Bembidium bipustulatum, Macleay, Trans. Ent. Soc. N.S. Wales, ii., 1871, p. 116 (*non* Sloane, 1896).—*T. froggatti*, Sloane, Proc. Linn. Soc. N.S. Wales, xxi., 1896, p. 362.

The late Rev. Thos. Blackburn drew my attention to the fact that Macleay's description of *T. bipustulatus* suited my *T. froggatti* better than the species to which I assigned it in 1896, and, on reading that description with both these species before me, I found this opinion correct. I then again examined the specimens of Masters' collecting from Gayndah in the Australian Museum, which must be taken to be those Macleay had before him, and found there were two specimens gummed on one card which were of the two species under discussion. Before I knew *T. bipustulatus*, I had compared the specimen I had of the species I now name *T. solidus* with these specimens from Gayndah, and, finding it agreed with one of them, had not noticed what the other was; as a result, the species which I had wrongly identified bore the name *T. bipustulatus* Macl., in my collection, when I got the true *T. bipustulatus* in 1896, so I regarded this as an undescribed species. It is evident that Macleay's statements "thorax narrowed behind" and "legs, palpi and antennae yellow" are more applicable to the species I called *T. froggatti* than to that identified by me in 1896 as *T. bipustulatus*; therefore, Blackburn's view must be upheld.

TACHYS SOLIDUS, n.sp.

T. bipustulatus, Sloane (*non* Macleay), Proc. Linn. Soc. N.S. Wales, xxi., 1896, p. 363.

Robust, oval, convex. Front shortly bi-impressed. Prothorax transverse, wider across base than apex; sides lightly rounded anteriorly, a little narrowed and subsinuate to base; basal angles rectangular; a curved transverse impression across base. Elytra ovate, convex, 5-striate; striae simple, first entire, 2—5 not reaching base, 3—5 successively shorter distad, not extending on to apical declivity, eighth entire, deep; ninth interstice convex; disc bipunctate on third interstice; a puncture on inner side of apical striole far back. Shining bronzed black; elytra bimaculate towards apex; antennae infuscate, basal joint testaceous, second and third joints subtestaceous with a dark median ring; legs light brown, femora darker than tibiae. Length, 2.9; breadth, 1.9 mm.

Hab.—Queensland: Laura River (Sloane), Townsville (Dodd), Gayndah (Masters); N.S. Wales: Junee (Sloane). Habits riparian.

Very like *T. bipustulatus* Macl., with which Macleay (and Masters, too), confused it (*cf.* under *T. bipustulatus*, *supra*), but differing by prothorax a little more rounded on sides, and a little more narrowed to base; elytra with five (not six) inner striae present.

TACHYS HELMSI Sloane (1898).

Hab.—W. A.: Upper Ord River (Helms); Queensland: Upper Normanby River (Sloane). East Indian Islands.

I have no note of the circumstances under which I found this species. A specimen from some locality in the East Indies, which I cannot decipher, was among the duplicates of the Van de Poll Collection.

TACHYS OVENSENSIS Blackburn (1890).

Hab.—Victoria: Ovens, Goulburn and Yarra Rivers. I found it in December at Jamieson on pebble beds at the margin of the Goulburn River.

TACHYS FLAVICORNIS, n.sp.

Oval, convex. Head with short duplicated frontal sulci; prothorax of equal width at base and apex, basal angles rectangular, a short submarginal carina on each side of base; elytra bistriate on each side of suture, eighth stria strongly impressed, apical striole well developed, ninth interstice convex, disc bipunctate outside second stria. Head and prothorax polished brown; elytra nitid, piceous, with wide humeral and ante-apical yellowish maculae; legs, antennae, and palpi testaceous.

Head wide; frontal sulci not crossing clypeus, extending backward to level with anterior supra-orbital seta; eyes prominent, hemispherical. Prothorax transversely subcordate; sides rounded on anterior two-thirds, evidently narrowed and shortly subsinuate to base; lateral channel wide; border wide, reflexed; lateral basal impressions deep, connected by a well-marked transverse impression; space between basal impression and lateral channel forming a short carina extending to basal angle on each side. Elytra oval, convex; shoulders ampliate, rounded; base with a deep fovea on each side of peduncle; first stria extending to apex, not reaching base, second stria abbreviated anteriorly and posteriorly. Length, 2.5; breadth, 1.0.

Hab.—Queensland: Cooktown District (Sloane), Townsville (Dodd). I found this species, in July, on the sandy margins of pools in the Laura River, and beside a pool with sandy margins in the course of a rivulet near Helenvale, 16 miles south of Cooktown.

T. flavicornis is not closely allied to any other Australian species; its affinity is to *T. deliciolus* Bates (which I have from Java, Sumbawa, and New Guinea), but it differs by antennae wholly testaceous; prothorax more transverse, more strongly rounded on sides, more sinuate posteriorly, wider across base, marginal channel wider; elytra wider, especially at base, first stria not reaching base, light-coloured basal maculae overspreading more of the elytra.

Note.—*T. nietneri* Bates (=*T. ornatus* Nietner), which is unknown to me in nature, seems the only closely allied Oriental species with the antennae wholly testaceous; it cannot be said to be described, but Nietner's note on it says, in comparison with his *T. emarginatus*, "*corpore graciliore*"—*T. flavicornis* is a more robust species than *T. emarginatus*.

TACHYS CONVEXUS Macleay.

Bembidium convexum, Macleay, Trans. Ent. Soc. N.S. Wales, ii., 1871, p. 115.— *Bembidium bistriatum*, Macleay, *ibid.*

The name *T. bistriatus* was already in use when Macleay proposed it in 1871, therefore *T. convexus* must be used. I have on several occasions carefully

examined the original specimens from Gayndah in the Australian Museum under the names *T. convexus* and *T. bistriatus,* and am certain both names belong to the same species.

Hab.—Tropical Australia (widely distributed); extending as far south as the Blue Mountains in New South Wales. I found it in the Cooktown District in very damp places, often beside springs.

TACHYS HAEMORRHOIDALIS Dejean (1831) var. CURTICOLLIS Sloane (1896).

Hab.—Coastal districts of Eastern Australia, from Cooktown to the Murrumbidgee River, on margins of fresh water creeks and lagoons.

I cannot now separate my *T. curticollis* from the Palearctic species *T. haemorrhoidalis,* except by its 4-maculate elytra; the same pattern occurs in var. *socius* Schm., of North Africa, which is unknown to me in nature. *T. emarginatus* Niet., which is widely spread in the Oriental Region (*T. geminatus* Schaum., seems a synonym), differs from *T. haemorrhoidalis;* the sculpture of the head is the most evident difference: frontal sulci longer and deeper, space between sulcus and margin of head on each side longitudinally striolate.

The following is the synonymy of *T. haemorrhoidalis,* as far as I know it:—

T. haemorrhoidalis Dejean (=*T. kanalensis* Perroud, 1864, New Caledonia).
var. *socius* Schaum (1863); 4-maculate form of N. Africa.
var. *curticollis* Sloane (1896); 4-maculate form of Australia.
var. *abyssinicus* Chaudoir (1876); immaculate form of Africa.

TACHYS SPENCERI Sloane (1896).

Hab.—Western Australia: King's Sound (Froggatt), Upper Ord River (Helms); Queensland: Cooktown District (Sloane), Kuranda and Townsville (Dodd); Central Australia (Spencer).

I found it very plentiful in the Cooktown District beside fresh water, hiding in the roots of grass, under stones, and under bark of fallen logs leaning into the water.

TACHYS IASPIDEUS Sloane (1896).

Hab.—N.S. Wales: Tamworth and Inverell (Lea), Mudgee (Sloane); Queensland: Coomera (south of Brisbane, Sloane). Habits riparian; I found it not uncommon, in February, among the pebbles of a stone-bed on the Cudgegong River, near Mudgee.

TACHYS MURRUMBIDGENSIS Sloane (1894).

This species varies in size from 1.75 to 2.4 mm. in length; I obtained three specimens of larger size (2.6—2.75 mm.), in company with specimens of ordinary size, hibernating beneath the bark of a red-gum tree beside the Macquarie River at Narromine in July; I cannot differentiate these large specimens from the typical form.

Hab.—On sand banks and pebble beds by the margins of rivers in N.S. Wales: Murray River (Mulwala), Murrumbidgee River (Narrandera), Cudgegong River (Mudgee), Macquarie River (Narromine).

TACHYS LEAI Sloane (1896).

This species is very close to *T. murrumbidgensis* Sl., from which it differs chiefly by its black colour; prothorax polished, with faint and microscopic puncturation, more convex and rounded on sides. When describing *T. leai,* I recorded

that the prothorax is impunctate, but this is an error; an examination of the cotype in my collection under a microscope discloses a faint and sparse puncturation.

TACHYS WILSONI, n.sp.

Robust, convex. Prothorax transverse, subcordate; elytra convex, smooth, sutural stria strongly impressed, fifth present on basal third, apical striole short, wide, near margin. Head brown; prothorax and elytra ferruginous, nitid; legs and antennae testaceous.

Head stout; frontal sulci parallel, short, not deep. Prothorax rounded on sides, shortly sinuate before posterior angles; base truncate above peduncle, sloping lightly obliquely forward on each side. Elytra oval; eighth stria obsolete; a foveiform impression a little inward from apical striole; three fixed punctures present, anterior at position of fourth interstice, posterior high up on apical declivity; second stria obsolescent, faintly perceptible between discal punctures; a puncture at anterior extremity of apical striole. Length, 2; breadth, 0.9 mm.

Hab.—Queensland. A specimen was kindly given to me by Mr. F. E. Wilson, who found it at Brisbane in October.

A very distinct species, more allied to *T. leai* Sl., than to any other species known to me, but differing decidedly by colour; smaller size; head shorter, frontal sulci shorter and more parallel, eyes less prominent; elytra more oval and much more convex, discal striae (excepting first and basal part of fifth) almost completely lost. Comparing it with *T. australicus* Sl., the presence of the strongly impressed basal part of the fifth stria at once distinguishes it. The head and prothorax have some microscopic punctures, which are stronger on the head.

TACHYS ECTROMIOIDES Sloane (1896).

Hab.—N.S. Wales: Richmond River (Lea), Blue Mountains (Carter); Victoria; Melbourne (Fischer); W. Australia: Donnybrook (Lea).

This seems to be a rare species, I know nothing about its habits.

TACHYS ATRIDERMIS, n.sp.

Oval, robust, convex. Head convex, frontal furrows well marked, clypeus with lateral punctures foveiform; prothorax transverse, evidently narrowed to base, lateral basal impressions deep, basal angles rectangular; elytra oval, bistriate on each side of suture, eighth stria entire, first interstice raised, ninth interstice depressed, disc bipunctate, apical striole well developed, short. Black, legs ferruginous; antennae infuscate with base ferruginous; palpi infuscate.

Head wide, convex; frontal impressions elongate, lightly divergent posteriorly, not extending on to clypeus; space between frontal impression and eye on each side narrow, raised, bearing a foveiform setigerous puncture posteriorly; antennae stout, second joint rather shorter than third. Prothorax widest a little before middle, a little wider at base than apex; sides lightly roundly ampliate before middle, obliquely narrowed to base; lateral border reflexed; space between lateral basal fovea and margin raised into a short carina; a deep transverse linear basal impression extending inwards from each lateral fovea, but not meeting in middle. Elytra oval; two or three crenulate striae on disc, first entire, second hardly perceptible on apical third, but developed into a shallow oblong fovea between apical striole and suture; a well marked basal fovea on each side of scutellum; two fine punctures on disc outside second stria, a dis-

tinct puncture near inner side of apical striole far back. Length, 2.6; breadth, 1.2 mm.

Hab.—Victoria: Belgrave (Wilson), Mountains of Upper Yarra (Fischer). I owe a specimen to the kindness of Mr. Fischer. Colls. Wilson, Fischer, and Sloane.

It is probably allied to *T. baldiensis* Blackb., which is unknown to me in nature, but is smaller, and does not agree with the description of that species; for one thing, the striae are not on the disc *"crassissime punctulatis."* The male has one setigerous fovea on each side of the apex of the abdomen; Blackburn has noted that *T. baldiensis* ♀ has two large setiferous punctures on each side. The anterior tarsi have the two basal joints dilatate, the posterior tarsi are shorter than usual in the genus, first joint not as long as three succeeding joints together, hardly as long as fifth.

TACHYS CARINULATUS, n.sp.

♀. Robust, oval. Prothorax transverse, decidedly narrowed to base, a short submarginal carina near each basal angle; elytra bistriate on disc, bipunctate on disc at position of third interstice, eighth stria obsolete on basal half, apical striole short, distinct. Piceous, apical declivity and posterior part of lateral declivities of a more or less dull ferruginous colour; antennae fuscous, basal joint and legs testaceous.

Head laevigate; front lightly and shortly bi-impressed. Prothorax broader than long, a little wider at base than apex; base truncate, angles rectangular; a transverse stria near base. Elytra oval, much wider than prothorax; first stria fine, but well marked, a little punctate, second very faint; border wide, reflexed; a puncture beside inner side of apical striole far back, space between apical striole and eighth stria narrow, carinate. Length, 2; breadth, 1.1 mm.

Hab.—Victorian Alps (Hospice, Mt. St. Bernard, Davey).

I owe a single specimen of this species to the kindness of Mr. H. W. Davey; it is a distinct species, in some ways resembling *T. mulwalensis* Sl., but with a submarginal basal carina on each side of prothorax as in *T. atridermis* Sl., beside which I have placed it in the table above; from *T. atridermis* it is readily differentiated by size smaller; form less convex; front less strongly bi-impressed; elytra much less strongly striate on disc, eighth stria not entire.

TACHYS MITCHELLI Sloane (1894).

Hab.—N.S. Wales: Urana and Mulwala (Sloane); Victoria: Sea Lake (Goudie). Found beside fresh water marshes in muddy situations under logs and debris.

TACHYS MULWALENSIS Sloane (1899).

Hab.—Murray River, Mulwala and Albury (Sloane); Melbourne (Fischer).

Length, 3 mm. (Melbourne specimens, 2.5 mm.). ♂ with basal joint of anterior tarsi wide.

In my description the length was erroneously given as 2 mm.; a remeasurement of the type specimens shows the correct length to be 3 mm. I obtained this species in great numbers under the bark of redgum trees standing in the flood waters of the Murray River; specimens were also found in the debris washed up by flood waters at Albury. Mr. Ejnar Fischer has sent me very dark coloured specimens from Melbourne, with the information that he finds it not uncommon under the bark of trees.

TACHYS BIFOVEATUS Macleay.

Bembidium bifoveatum, Macleay, Trans. Ent. Soc. N.S. Wales, ii., 1871, p. 117.—*Bembidium ovatum,* Macl., *ibid.*—*Tachys ovatus* Macleay (*non* Motschulsky) Sloane, Proc. Linn. Soc. N.S. Wales, xxi., 1896, p. 369.

Widely spread in Eastern Australia, and also occurring in Tasmania. It is usually found in very damp situations under stones or drift, but Mr. H. J. Carter finds it commonly in tussocks of grass in his grounds at Wahroonga, near Sydney. It is a species of Motschulsky's genus *Elaphropus*, which has the claws of the tarsi minutely serrulate (as recorded by Motschulsky and G. H. Horn). I do not recognise *Elaphropus* as of more than subgeneric rank. In this group (which is numerously represented in the Oriental Region) only one discal non-setiferous puncture occurs on the disc of the elytra, behind the middle, at the position of the third interstice; there is, also, a puncture at the inside of the apical striole far back from its anterior extremity, but no setiferous pore high up on the apical declivity.

TACHYS BLACKBURNI, n.sp.

Oval, convex. Black; legs testaceous; antennae infuscate, with basal joint testaceous.

Head convex; front lightly bi-impressed, impressions short, wide apart. Prothorax small, laevigate, widest a little before middle; sides rounded anteriorly, lightly subsinuately narrowed to base; basal angles rectangular, not prominent; base bifoveate; a light transverse impression between basal foveae. Elytra oval, rather convex, bistriate on each side of suture; first stria well marked, entire, punctate on disc, simple towards apex, second stria only present on disc, punctate, eighth stria obsolete on middle of sides, distinct towards apex; apical striole well developed; marginal channel distinctly punctate on middle of sides; disc bipunctate outside second stria. Length, 2; breadth, 0.75 mm.

Hab.—Victoria: Beaconsfield ("in moss," Wilson), Mooroolbark (under a stick in a muddy place, Sloane).

A distinct species resembling *T. olliffi* Sl., and *T. habitans* Sl., but with elytra only bistriate, it is more allied to *T. carinulatus* Sl.

TACHYS AUSTRALICUS Sloane (1896).

Hab.—Eastern coastal districts from Cooktown to Sydney; found in very damp situations beside fresh water marshes and pools under drift or debris.

Note.—In the description of *T. australicus,* I have said the elytra are without discoidal punctures, but this is erroneous, two fine punctures are present on the disc at position of third interstice; the elytra have only the two inner striae present.

TACHYS DODDI Sloane (1903).

Hab.—Queensland: Townsville (Dodd); Victoria: Lakes Entrance (Wilson). Common on sandy margins of tidal lagoons near Townsville.

Note.—I have in my collection a Malayan species which cannot be differentiated from *T. doddi,* though the basal angles of the prothorax are a little less acute; it seems to vary a good deal in size, and may be conspecific with Putzey's *T. plagiatus,* or his *T. pictipennis,* which may be forms of one species, but I have not felt able to be certain on this point. Length, 2.5—3 mm.

Hab.—Philippines, Celebes, Sumbawa.

TACHYS QUEENSLANDICUS Sloane (1903).

I found this species common on the sandy margin of a tidal lagoon at Townsville in May.

T. cruciger Putzeys (1875). I have a specimen ticketed Celebes which I cannot differentiate from *T. queenslandicus,* though the colour is darker, and more iridescent, and the spots of the elytra are more clearly defined and do not approach each other so closely on the sides; I believe this is likely to be *T. cruciger* Putz., but am not absolutely sure on the point.

TACHYS INFUSCATUS Blackburn (1887).

Hab.—Western Australia: Swan River (Lea); South Australia (Blackburn); Victoria (Fischer). Mr. Ejnar Fischer has informed me that *T. infuscatus* is common near salt water about Melbourne. Blackburn has drawn attention to the great resemblance of *T. similis* Blackb., to *T. scutellaris* of the Palaearctic Region (Trans. Roy. Soc. S. Aust., xxv., 1901, p. 122), but *T. infuscatus* resembles *T. scutellaris* even more closely than *T. similis* does.

TACHYS SIMILIS Blackburn (1887).

Hab.—South and Central Australia. Specimens were sent to me by Mr. A. M. Lea from Adelaide, Flinders Range, Oodnadatta, and Cunnamulla.

Blackburn differentiated *T. similis* from *T. infuscatus* by colour; shorter, broader and more depressed form; posterior angles of prothorax "though obtuse not far from right angles." With these views I agree, but would note that in *T. similis* the prothorax is more transverse and its base is less strongly oblique on each side behind the basal angles, the summit of the angles does not appear to me to differ perceptibly, but the greater slope of the sides of the base makes the angles in *T. infuscatus* seem more obtuse.

TACHYS SINUATICOLLIS Sloane (1903).

Hab.—Queensland: Cairns; Celebes; Java.

Mr. Lea sent me a good series of specimens ticketed "Cairns, taken at light"; and numerous specimens from Celebes and Java were among the duplicates of the Van de Poll collection.

TACHYS TRIANGULARIS Nietner (1858).

Hab.—Africa; Oriental Region; Australia.

As long ago as 1873 Bates had recorded that *T. atriceps* Macleay (1871) was a synonym of *T. triangularis* Niet.

TACHYS MASTERSI, nom. nov.

Bembidium sexstriatum, Macleay, Trans. Ent. Soc. N.S. Wales, ii., 1871, p. 117 (*nom. praeocc.*).

The name of *T. mastersi* is now proposed to replace *T. sexstriatus* Macleay, which had been used for a species of *Tachys* as long ago as 1812.

Hab.—Queensland: Gayndah (Masters), Cairns and Cooktown District (Sloane). I found specimens on the sandy margins of a pool in a rivulet at Helenvale, near Cooktown.

TACHYS MACLEAYI Sloane (1896).

Hab.—Tropical Australia: King's Sound (Froggatt); Queensland: Cooktown District (Sloane). I obtained several specimens on a sand bank at the margin of the Normanby River in June.

Genus LIMNASTIS.

Lymnastis, Motschulsky, Etud. Ent., xi., 1862, p. 27.

The original spelling of this generic name has been altered by later authors. The range of the genus extends over Australia, Malaysia, Asia, Africa, Europe, North and Central America.

LIMNASTIS PILOSUS Bates.

Ann. Mus. Civ. Genov., xii., 1892, p. 296; Sloane, Proc. Linn. Soc. N.S. Wales, xlv., 1920, p. 321.—*Tachys setiger*, Sloane, Proc. Linn. Soc. N.S. Wales, xxviii, 1903, p. 582.

Hab.—Australia: Oenpili (Cahill), Cairns (Sloane), Townsville (Dodd), Melbourne (Fischer); Borneo; Burma.

Genus ILLAPHANUS.

Elytra non-striate on disc, 1.5—2 mm. (after Lea) .. .. *macleayi* Lea
Elytra with a single strong oblique longitudinal stria on disc. 1.3—1.5 mm. *stephensi* Macl.

ILLAPHANUS STEPHENSI Macleay (1864).

Hab.—Port Jackson (Lea), Wollongong (Macleay), Ferntree Gully (Spry).

These insects, according to Lea, are found under stones deeply buried in damp, but not wet, soil.

ORDINARY MONTHLY MEETING.

25TH MAY, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Messrs. George Davenport Osborne, B.Sc., Belle-vue, Kembla Street, Arncliffe and Montagu Austin Phillips, F.L.S., Devonshire House, Reigate, Surrey, were elected Ordinary Members of the Society.

The President announced that the Council had elected Messrs. W. W. Froggatt, F.L.S., A. G. Hamilton, Professor H. G. Chapman, M.D., B.S., and J. J. Fletcher, M.A., B.Sc., to be Vice-Presidents; and Mr. J. H. Campbell to be Honorary Treasurer for the current session, 1921-22.

The congratulations of members were offered to Mr. J. J. Fletcher, M.A., B.Sc., and the following resolution, passed by the Council, was read to the meeting:—That the following resolution be recorded in the minutes of the Council, and also be read at the next Ordinary Monthly Meeting of the Society:—That the hearty congratulations of the Council and of the Society be conveyed to Mr. J. J. Fletcher, M.A., B.Sc., on the award to him, by the Royal Society of New South Wales, of the Clarke Memorial Medal for his distinguished services to Natural History in Australia.

The congratulations of members were offered to Mr. R. J. Noble, B.Sc., (in absentia) on his selection by the Ben. Fuller Trust as the first travelling scholar in Agricultural Science.

A letter was read from Professor T. T. Flynn, returning thanks for congratulations on attaining his doctorate in Science.

The Donations and Exchanges received since the previous monthly meeting (27th April, 1921), amounting to 2 Vols., 114 Parts or Nos., 30 Bulletins, 2 Reports and 2 Pamphlets, etc., received from 39 Societies and Institutions and three private donors, were laid upon the table.

NOTES AND EXHIBITS.

Mr. W. W. Froggatt exhibited a series of the Painted Shield Bug, *Tectocoris lineola,* showing the variations in colour; also live adult larvae and eggs. As these bugs are found infesting native *Hibiscus,* and migrate on to the cultivated cotton, they are of some economic importance.

Mr. W. F. Blakely exhibited from the National Herbarium two new weeds for the State. (1). *Amarantus deflexus* L., "Low Amaranth." Common on the railway line between Cowan and Hawkesbury River. (W. F. Blakely and D. W. Shiress, February, 1921). This plant is widespread throughout Europe, and ap-

pears as a weed in other parts of the world. It has the general appearance of *A. macrocarpus* Benth., a native species, from which it differs in the mostly terminal, slender paniculate inflorescence, and in the relatively smooth pericarp. Professor Ewart (Proc. Roy. Soc. Vic., xxxii., 1920, 190) records it for Victoria. (2). *Xanthium commune* Britt., the "Common Cockleburr" of America, which was recently forwarded for identification by Mr. C. A. Horning, of Ebenezer. On investigation two other specimens were found under *X. strumarium* the "Noogoora Burr", namely from Cattai near Windsor (V. C. Giles, 1915), and near Dunedoo (M. Beahan, 1918), thus indicating that this obnoxious plant is spreading unnoticed. The new burr is similar in habit to the "Noogoora," but is readily distinguished from it by the more ovate, densely uncinate pubescent burrs. As far as can be ascertained, it is new for the Commonwealth.

Mr. Blakely also exhibited fresh specimens of *Euphorbia Drummondii* Boiss., from Barellan (T. A. Field), with the leaves, flowers, and fruits infested with bright pink galls, which gave the plant a striking floral appearance. It is not known what physiological change the galls would impart to the plant, or whether they would be injurious to grazing animals.

Mr. A. S. Le Souef exhibited a live specimen of *Moloch horridus* from Ooldea, where it is numerous on the sandhills on which it lays its eggs. A clutch of eight eggs was found in December last. These lizards feed on small black ants.

Dr. E. W. Ferguson exhibited a series of ten species of *Tabanidae* forwarded from the British Museum as exchanges.

Dr. A. B. Walkom exhibited a specimen, probably the flower of a Mesozoic *Cycadeoid,* from the Triassic Rocks of Ipswich, Queensland.

The President asked members to hand notice of their intention to exhibit to the Secretary before the commencement of each meeting, in order to facilitate the business.

ON A NEW SPECIES AND A NEW VARIETY OF *DIOSPYROS*.*

By W. P. Hiern, M.A., F.R.S.

(*Communicated by J. H. Maiden, F.R.S.*)

Diospyros austrocaledonica, n.sp.

Arbor (ut videtur) novitiis infructescentiâque et c. exceptis glabriuscula, ramulis teretibus fuscis minute glanduloso-puberulis subnitidis foliosis, internodiis 18—28 mm. longis, foliis ovali-oblongis apice obtusis non vel vix acuminatis interdum late emarginatis basi leviter cuneatis firmiter coriaceis sub-concoloribus utrinque sordide viridibus alternis integris 7—22 cm. longis 3—7.5 cm. latis margine anguste revolutis costâ validâ super sulcatâ infra prominente conspicuâ concolore vel basim versus fusciore venis, lateralibus alternis utrinque circiter decem patulo-ascendentibus sub-tenuibus concoloribus reticulatione etiam tenui concoloreque petiolo robusto fusco 9—15 mm. longo plus minus patulo, fructibus sub-globosis vel late spheroideis breviter pubescentibus 20—25 mm diam. solitariis 8?—loculatis, pedunculis fructiferis axillaribus solitariis 3—5 mm. longis patulis puberulis calyce fructifero 4—5 fido 3—4 cm. diam. tubo plerumque scutelliformi ceterum reflexo extus puberulo intus sericeo—tomentello duro coriaceo 18—22 mm. diam. lobis patulo-reflexis coriaceis puberulis ovato-rotundatis 1—1.5 cm. longis 1—1.75 cm. latis infra plus minus concavis saepius undatis, seminibus pluribus 14—17 mm. longis 7—8 mm. latis 4 mm. crassis testâ tenue albumine albido equabili copioso cartilagineo. Embryon 6.5 mm. longum radiculâ sub-cylindraceâ 4.5 mm. longâ 0.5—1 mm. latâ. Cotyledonibus ovalibus 2 mm. longis 1.5 mm. latis.

Hab.—New Caledonia, Baie du sud. Coll. Le Boucher, 1903, No. 1529.

Differs from *D. Olen* Hiern., by the size of the leaves, length of the petioles, *etc.*

Diospyros samöensis, A. Gray var. ovata, n.var.

Plerumque glabrata, novitiis puberulis, ramulis sub-gracilibus fuscis alternis foliosis apice minute puberulis, internodiis 7—30 mm. longis, foliis alternis ovatis vel ovato-ellipticis apice breviter obtusiusculis vel vix acuminatis basi

*[We owe to Mr. Hiern, of Barnstaple Manor, Devon, England, a well-known monograph on the *Ebenaceae*, and the specimens herein described were forwarded to the National Herbarium of New South Wales, and transmitted by me for Mr. Hiern's consideration.—J.H.M.]

sub-rotundatis vel inaequaliter angustatis tenuiter coriaceis super caesio-viridibus sub-nitidis subtus sub-sordidis margine integris anguste revolutis 7—10 cm. longis 3.5—4.6 cm latis costâ mediocri subtus prominente fuscâ nervis lateralibus gracilibus reticulatione inconspicuâ petiolo fusco 3—6 mm. longo, pedunculo fructifero axillari erecto-patulo solitario valido puberulo 6—7 mm. longo, calyce fructifero patente puberulo 4—lobo 16—17 mm. diam dure coriaceo tubo crasso brevissime cupulari 10 mm. diam. annulo interno elevato instructo lobis ovatis patulo-recurvis obtusis undatis, fructibus sub-globosis glabratis vel obsolete pubescentibus levibus 15—19 mm. longis 14—16 mm. diam 8—? loculatis, seminibus plurimis albumine aequabili.

Hab.—Apia, Samoa. Coll. Dr. B. Funk, 1901, n. 19.

Differs from the type of the species by the broader shape towards the base of the leaves.

ULMITE, A CONSTITUENT OF BLACK SANDSTONE.

By Thos. Steel.

At various points along the coast of New South Wales there occur frequent outcrops of a black friable sandstone. The positions of some of these in the Richmond River district are indicated on maps published by the New South Wales Department of Mines (Ann. Rept., 1895, p. 151; 1896, p. 155).

At Tweed Heads a thick bed is exposed on the north bank of the river near the township, from which the sample described in this paper was obtained. There is no igneous rock near the deposit which is covered by a layer of ordinary sand of varying thickness. Water collected in wells dug in the overlying sand is brown in colour.

The rock is very friable, rubbing readily between the fingers to a sharp sand. On ignition a fragment crumbles to loose sand and becomes white. A portion heated in a glass tube yields water having a strongly acid reaction.

Under the microscope the rock is seen to be built up of worn sandgrains of fairly uniform size, each of which is covered with a thin dark-coloured film resembling a coat of varnish. Gentle friction suffices to remove the coating from the sand grains. On lixiviating the pulverised rock the dark coating can be readily separated and obtained quite free from sand and, when dry, forms a dark brown powder. Microscopically this shows as irregular flakes of varying thickness, the thinner ones being structureless and of a translucent brown colour, while the thick ones are black and opaque. The translucent flakes do not affect polarised light, and, as will be shown, chemical examination proves the substance to consist of humus or humic acid. The powder is readily and completely soluble in caustic potash, soda or ammonia, forming a clear deep-brown liquid which, on acidifying with sulphuric or hydrochloric acid, deposits a copious brown flocculent precipitate, leaving the solution moderately coloured. In strong sulphuric acid the dark powder dissolves readily, particularly on slightly warming, forming a clear, very dark brown solution, which, on being poured into a large volume of water, throws down a copious soft brown precipitate, leaving the solution only slightly coloured. In strong nitric acid, the powder dissolves readily, but no precipitate is produced on dilution with water nor on neutralisation with alkalies. Even on boiling, the substance is only sparingly soluble in strong hydrochloric acid.

When the precipitate obtained by dilution of the solution in strong sulphuric acid is drained on a filter, the resulting slimy mass is readily soluble in water

and also in strong spirit, giving a solution resembling caramel. The water solution obtained in this way, when treated with barium hydrate or carbonate becomes colourless the. substance being carried down along with the barium sulphate. The dark brown solution obtained by treating a dilute solution of soda or potash with excess of the substance, is readily precipitated with alcohol, the supernatant liquid having still, however, a fairly dark colour. A solution in potash, on neutralisation with sulphuric acid, avoiding excess, remains clear and is precipitated by addition of alcohol. The precipitate may be thoroughly washed with dilute alcohol (Sp. Gr. 0.86), after which it dissolves readily in water, the solution so formed not being precipitated by alcohol, but, if a small amount of potash or soda be added, alcohol produces a copious precipitate, leaving the solution only slightly coloured. The aqueous solution of the alcohol-washed precipitate gives brown precipitates with most metallic salts, precipitation being complete, also with the hydrates and salts of barium, calcium and strontium, with the alums, and with bromine water. Iodine, tannin and starch solutions produce no precipitate.

Amongst the few metallic salts which do not cause a precipitate are mercuric chloride and ammoniacal nitrate of silver. The colour is removed by shaking with hydrates of iron and alumina and with litharge, manganese dioxide, animal charcoal and ordinary soil, previous ignition of the soil making no difference. When shaken with sand the solution is decolourised, the colour, however, being absorbed entirely by the fine clayey portion of the sand, the coarser grains being inert. The same applies to treatment with the black sandstone, after ignition, but if sand or soil is boiled with hydrochloric acid and washed so as to remove soluble mineral matters, the residue is quite inert.

The substance can be salted out of solution with a number of salts, sodium chloride and sulphate, ammonium sulphate, nitrate and chloride and others, leaving the solution but faintly coloured. From concentrated solutions, acetic acid causes practically complete precipitation in a well curdled form, but from dilute solutions the precipitate is slimy but equally complete.

The barium compound prepared by precipitating the water soluble preparation with baryta water, washing with alcohol, and drying, corrected for associated mineral matter, contains 41.3 per cent. barium oxide.

The pulverised air-dry rock yielded the following figures to proximate analysis:—

Water	1.63
Loss on ignition	8.19
Sand	89.50
Soluble in hydrochloric acid	.68
	100.00

When the coating from the black sandstone is lixiviated until quite free from sand and air-dried, it has the following proximate composition:—

Water at 150° C.	17.3
Loss on ignition	67.6
Mineral	15.1
	100.0

On boiling 0.5 gram with 50 c.c. N/10 caustic soda and titrating back with corresponding sulphuric acid, 24.7 c.c. of neutralisation was obtained.

This preparation, after drying at 150° C., calculated free from mineral matter, gave the results below, on ultimate analysis. Humus is known to have a somewhat variable composition according to source and method of preparation. When made from sugar, for instance, it may be quite free from nitrogen. For comparison I have inserted analyses of humus from a number of sources, references to which are given.

Analyses of Humus Derived from Various Sources.

	1.	2.	3.	4.
Carbon	50.53	57.75	53.42	52.71
Hydrogen	5.67	5.43	5.16	3.98
Oxygen	43.20	36.02	40.92	41.49
Nitrogen	.60	.80	.50	1.82
	100.00	100.00	100.00	100.00

1. Black sandstone. New South Wales.
2. Brown Peat. Watt's Dict. Chem., vol. viii., 1879, p. 649.
3. Decayed Fir wood. } Jour. Chem. Soc., 1906, Abs. ii., p. 388.
4. Decayed Oak wood. }

A preparation of humus made by treating black soil from Blackheath, N.S. Wales, with potash, and precipitation with sulphuric acid, behaved in all respects in a manner identical with the black sandstone preparation.

I would propose the name Ulmite for this form of humus as found coating sandstone grains.

Samples of black sandstone were supplied to me by Mr. W. S. Dun, of the Department of Mines, from McAuley's lead, Esk River; Iluka, Clarence River; and Sans Souci, near Sydney. They were in all respects similar to my specimen from Tweed Heads.

A similar coating to the above occurs on the rounded grains and pebbles of rock phosphate which constitute the surface "soil," four to six inches in depth, on Ocean Island (Jour. Soc. Chem. Ind., xl., 1921, p. 59T).

NOTES ON SOME DIPTERA FOUND IN ASSOCIATION WITH TERMITES.

By Gerald F. Hill, F.E.S.

(Nine Text-figures.)

During investigations into the biology of Termites I have had occasion to open up the galleries of *Mastotermes darwiniensis* Frogg. and *Calotermes irregularis* Frogg. in the trunks of living trees, and in them I have frequently found the larvae and pupae of *Trypaneidae* and *Syrphidae*. As this mode of existence appears to be unusual, I propose to record some observations made in the Northern Territory and North Queensland in this connection and to describe as new one species belonging to the latter family.

In a recent paper (1921) I have referred, *inter alia*, to the habit in *Mastotermes darwiniensis* of entering the trunks of living trees below the surface of the soil, and tunnelling upwards for some distance in the interior before making their appearance in the bark or sapwood. External evidence of such infestation is to be found in the presence of a discoloured watery exudation from cracks in the bark, and, later, in the deposit of an earthy cement-like material, moulded by the Termites to prevent the ingress of light and predaceous animals into the galleries which lie immediately beneath it. On removal of the protecting layer of bark and cement, these galleries are often found to contain a considerable quantity of fluid matter of more or less offensive odour. In or near this fluid I have found, (1) the eggs and larvae of *Rioxa termitoxena* Bezzi, in Coconut palms and Poinciana trees, in Darwin, Northern Territory, (2) the eggs, larvae and pupae of *Psilota* sp., in Poinciana and Mango trees in Darwin, (3) the larvae and pupae of *Psilota cyanea*, n.sp. in Fig trees (*Ficus* sp.) in Townsville, N.Q., and (4) the larvae and pupae of (?) *Microdon* sp., in Mango trees in Darwin. In an earlier paper (1915) I recorded having found the larvae of *Rioxa termitoxena* Bezzi (then undescribed) in the galleries of *Calotermes irregularis* in a living tree of undetermined species.

Family TRYPANEIDAE.

Rioxa termitoxena Bezzi.

An unsuccessful attempt was made to rear the young larvae of *R. termitoxena* in various fruits, and to induce the adults to breed in captivity. Under natural conditions the larvae reach maturity in the galleries of, and in amity with, the termites, then fall to the ground, where they pupate a few inches below the surface. The duration of the pupal stage is from 8 to 11 days. The

flies are occasionally found on foliage, but more often on the sunny side of tree-trunks, upon which they run about actively whilst displaying their wings in constantly changing positions. None of the introduced or indigenous fruits are known to be attacked by this species.

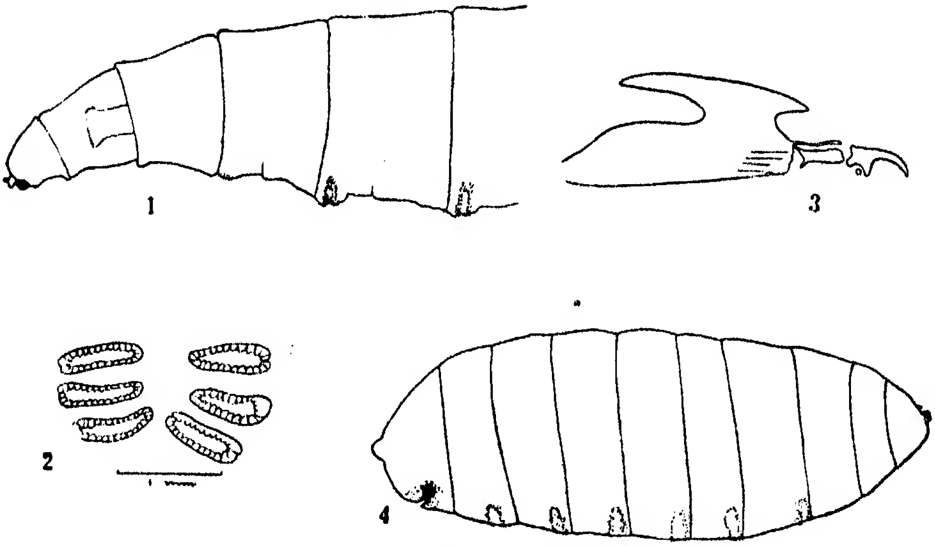
The imago has been fully described by Professor M. Bezzi (1919), to whom specimens were forwarded through the courtesy of Dr. G. A. K. Marshall. The larva and puparium may be briefly described as follows:—

Larva (Figs. 1—3).

Length, 11.0 mm.; width, 2.0 mm.; creamy white, with eleven visible segments; anterior end pointed, posterior end truncate, widest at 5th and 6th segments; anterior spiracles with from 12 to 14 processes.

Puparium (Fig. 4).

Length, 6.5 mm.; width, 2.70 mm.; short, broad; burnt sienna coloured; with 10 visible segments.



Rioxa termitoxena Bezzi.
Fig. 1. Anterior end of mature larva. Fig. 2. Posterior spiracles of mature larva. Fig. 3. Mandibles of mature larva. Fig. 4. Puparium.

Family SYRPHIDAE.

PSILOTA CYANEA, n.sp. (Figs. 5—9.)

I have noticed this species at only one tree, where the females were observed hovering near matter exuding from a termite-infested trunk or, in one case, ovipositing in a crevice from which the fluid was issuing. Larval development, and sometimes pupation, takes place in the galleries made by the termites; generally, however, the mature larvae leave the shelter of the galleries and

pupate in crevices in the adjacent bark. The duration of the pupal stage is about 12 days.

♂. Length to apex of abdomen, 6.25 mm.; to apex of wings, 8.00 mm.; wings, 8.00 mm.

Colour: Eyes maroon; antennae ochraceous tawny, shading to blackish on the third segment; thorax dusky blue with greenish reflections; abdomen dark bronze green; legs bronze green, basal half of first and second tibiae ochraceous tawny; halteres creamy; wings hyaline, slightly iridescent, veins brown, pterostigma yellow.

Head (Fig. 5) wide (2.70 mm.), wider than thorax; eyes holoptic, finely faceted, clothed with short brown pile (silvery in some lights); clypeus, epistome, and genae blue, not pubescent; rest of front aspect of head densely clothed with silvery pile and dust; antennae (Fig. 7, ♀) porrect, inserted about the middle of the head in profile, first joint about as long as, but narrower than second, both clothed with short, black hairs above, third large, compressed laterally, clothed with minute hairs, arista long, black, three-jointed, first two joints very short, the first shortest, third minutely feathered to the tip.

Thorax wide (2.35 mm.), a little narrower than head, clothed with short black hairs above (silvery in some lights) and more densely with longer hairs on the sides; scutellum large, semicircular behind, posterior margin with narrow upturned edge and fringed with many moderately large black hairs.

Wings (Fig. 8. ♀) without spurious vein, costal border fringed with very short stout black hairs, costal vein terminating at apex of wing at junction of third long vein, squamae moderately large, fringed with long slender pale hairs.

Legs moderately stout, femora of hind legs thickened, bearing a notched process near the apex, apparently similar to the female (Fig. 9), all joints densely clothed with stout black, white or golden hairs, pulvelli large, pale, feathered.

Abdomen wider than thorax, with four visible segments densely clothed with short black hairs (silvery in some lights), hypopygium concealed.

♀. Length to apex of abdomen, 5.25—6.25 mm.; to apex of wings, 7.0—8.25 mm.

Colour similar to male, or with scutellum dark bronze green and abdomen of same colour as thorax; antennae black; legs uniformly dark blue; halteres yellow ochre, frons and clypeus dark bronze green.

Head (Fig. 6): Frons wide at vertex, one-sixth the width of head, widening anteriorly to one-third the width of head at antennae, clothed with fine grey or white hairs, densest anteriorly, face and genae as in male. Ocellar triangle large, prominent; ocelli brown; eyes less pulose than in male, pile silvery.

Thorax as in male, but clothing shorter and scantier, very few long hairs fringing scutellum.

Wings (Fig. 8) as in male.

Legs (Fig. 9) as described in male, except in colour.

Abdomen wider than thorax, with five visible segments; genitalia prominent.

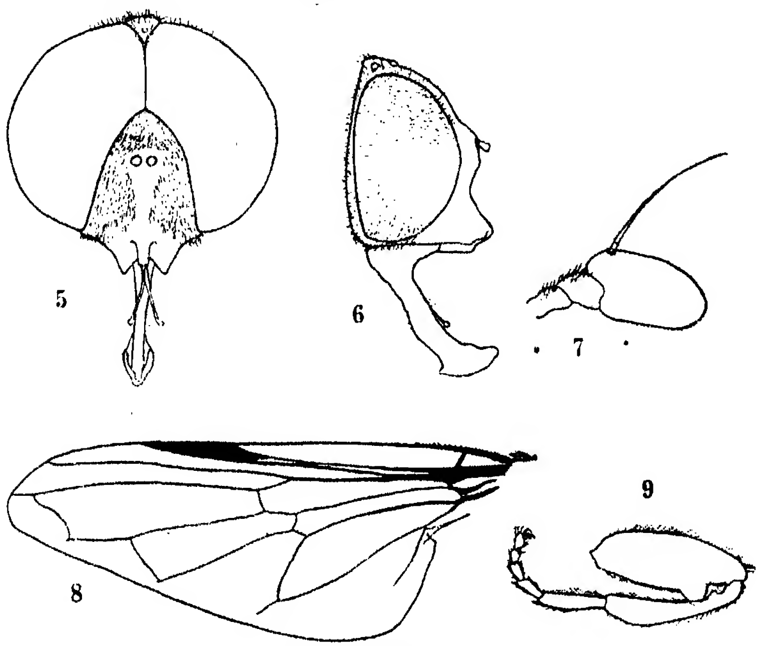
Larva.

Length, 12.0 mm.; width, 3.0 mm.

Colour: Cinnamon brown above, tawny olive below.

The whole upper surface dull, deeply and irregularly ribbed transversely, clothed with very short stout hairs. Head withdrawn into second segment; anterior end truncate in front and fringed with several rows of short stout

hairs; behind the anterior margin seven deep longitudinal furrows, the middle four terminating posteriorly at a prominent transverse ridge; apparently thirteen segments and a prominent cylindrical posterior breathing tube (1.25 mm. long); first visible segment 2.35 mm. wide, second, third and fourth increasing in width posteriorly, fifth and sixth widest; a pair of circular, slightly projecting, spiracular openings on the third visible segment; the three terminal segments much narrower than the preceding ones, the last with prominent lateral expansions. Under surface deeply furrowed like upper surface, the short stout antennae visible within the invaginated anterior end, the first, third, fourth,



Psilota cyanea, n.sp.
Fig. 5. Head of Male. Fig. 6. Head of female. Fig. 7. Antenna of female.
Fig. 8. Wing of female. Fig. 9. Hind leg of female.

fifth, sixth, seventh and eighth segments each with a pair of fleshy pseudopods, pear-shaped, with the pointed ends nearly meeting in the median line.

Puparium.

Length, 9—10 mm.; width, 3.5—4.0 mm.; height, 3.0 mm.

Colour as in larva.

The whole upper surface covered with particles of sand, bark and dried latex. Short and broad, bluntly pointed anteriorly, anterior end sloping down sharply from just before the long, slender, black, anterior spiracles. Posterior end very much narrowed, usually bent upwards or to one side, and terminating in the projecting posterior breathing tube described above. At emergence of the imago, the whole of the anterior end, including the spiracles, is pushed off at a diagonal suture extending from the lower anterior margin backwards around the dorsal surface just behind the spiracles.

Described from one male and two females. Holotype and paratype female in author's collection; allotype in National Museum, Melbourne. Male and female specimens in British Museum.

Locality. Townsville, N. Queensland (April, 1920).

PSILOTA SP.

Of the specimens bred out in the Northern Territory, only one male is available for examination. It differs from *P. cyanea* only in being slightly larger and darker and having antennae, apices of the femora and entire tibiae of the fore and hind legs tawny and the hind tibiae tinged with tawny. As no structural differences have been detected, it is regarded provisionally as a colour variety of the above described species.

I am indebted to Dr. G. A. K. Marshall for kindly examining specimens of *P. cyanea*, and for his opinion that this species has not been described hitherto.

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REVISION OF THE FAMILY *EUSTHENIIDAE* (ORDER PERLARIA) WITH DESCRIPTIONS OF NEW GENERA AND SPECIES.

By R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.L.S., F.E.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.; formerly Linnean Macleay Fellow of the Society in Zoology.

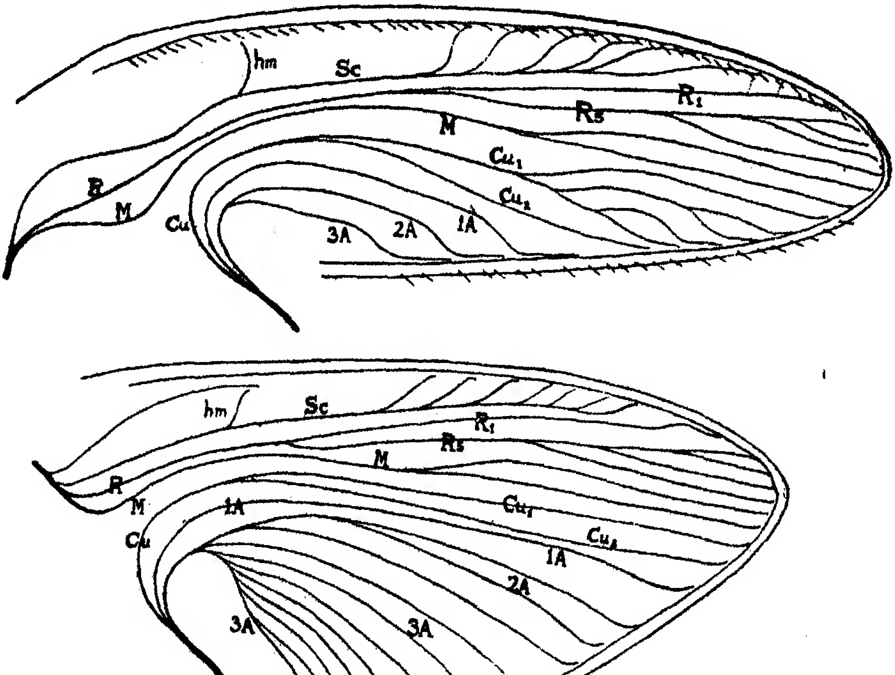
(Plates xi.—xv., and four Text-figures.)

In a paper published recently in the Canadian Entomologist (Feb., 1921, pp. 35—44), I have given a revision of the classification of the Order Perlaria, or Stone-flies, based on a study of the world fauna, with special reference to the archaic groups found in the Southern Hemisphere. In that revision, the *Eustheniidae* are, for the first time, definitely recognised as a distinct family, and their characters clearly defined. These large and, for the most part, very beautifully coloured Stone-flies are shown to possess only archaic family characters; in other words, though existing to-day, they represent the original archetypic family of the Order, from which all other types must have been derived. Their principal characters, all of which will be readily recognised as archaic, are the following:—the presence of five or six pairs of lateral abdominal gills in the larva; the close correspondence between the wing-tracheation of the larva and the wing-venation of the imago; the strongly formed imaginal mandibles; the normal structure of the clypeus and labrum; in the imaginal wing-venation, the absence of the transverse cord or anastomosis; the presence of cross-veins in all parts of the wing, including the anal fan; the forewing with three anal veins; the anal fan of the hindwing very large, and its margin forming a single continuous curve with that of the rest of the wing above the vena dividens (Cu_2). This last character serves to distinguish the *Eustheniidae* at sight from all other Perlaria.

At the present time, only four species appear to have been described which properly belong to this family. These are *Eusthenia spectabilis* Westwood (1832) from Tasmania, *E. costalis* Banks (1913) also from Tasmania, *Stenoperla prasina* (Newman), (1845), from New Zealand, and *Diamphipnoa annulata* (Br.), (1869), (=*D. lichenalis* Gerst, 1873) from Southern Chili. *Eusthenia thalia* Newm. (1839) from Tasmania, is not a true Eustheniid at all, but belongs to the family *Austroperlidae*. In my previous paper, already cited, I have proposed a new genus *Tasmanoperla* for the reception of this and the closely allied species *T. diversipes* Till.

During my visit to England, from June to August of last year, I studied the material belonging to this family in the British Museum, and also in the Hope Museum at Oxford. There is, fortunately, in the latter Museum, a very fine specimen of *Diamphipnoa annulata*, of which, through the kindness of Professor Poulton, I have received an excellent photograph. This is reproduced, enlarged, in Plate xiv., fig. 8. It will be readily seen that it is a true Eustheniid in every respect, thus justifying Banks' grouping of it with *Stenoperla* in his tribe Eustheniini, as opposed to Enderlein's placing of it in the family *Pteronarcidae*.

While in Melbourne in April, 1920, I went through the collections of the National Museum, and discovered there a magnificent new Stonefly, quite unlike anything hitherto known. It had been taken at Warburton, on the Upper Yarra River, many years previously (there is no date on the label), and had remained unnoticed for many years. The Curator kindly loaned me it for study, and I have been able to show it to many entomologists in England and America. This remarkable insect belongs to the family *Eustheniidae*, within which it will be placed, in this paper, as the sole representative of a new genus *Thaumatoperla*, forming the only known member of a new sumfamily *Thaumatoperlinae*. It is figured in Plate xi., fig. 1.



Text-fig. 1—*Stenoperla prasina* (Newman). Tracheation of wings of last larval instar. 1A, 2A, 3A, the three anal tracheae; Cu, cubitus; Cu_1, Cu_2, its two main branches; *hm*, humeral veinlet; M, media; R, radius; R_1, its anterior branch; Rs, its posterior branch, or radial sector; Sc, subcosta. (x 36).

The genus *Stenoperla* is already well known to me through a prolonged study of it during my visit to New Zealand in 1919-20. While staying with Professor Chilton at the Cass Biological Station in January, 1920, I took the opportunity to collect the larvae of the only known species, *S. prasina*, and to dissect off their wing-sheaths. The very beautiful wing-tracheation of this insect is shown in Text-fig. 1. Apart from a certain amount of fusion of the main veins at their bases, which is characteristic of the order as a whole, it will be seen that the courses of the tracheae are exactly those of the subsequently formed veins. This character indicates that no striking tracheational or venational specialisations occur in this family. The imago of *S. prasina* is shown in Plate xv., fig. 9.

Larvae of an unknown species of *Stenoperla* have long been known to me as occurring quite commonly in the fast mountain streams of the Blue Mountains and South Coast districts of New South Wales. In 1912, Dr. A. J. Turner, of Brisbane, captured a fine new *Stenoperla* at Montville, Blackall Ranges, Queensland, and sent it to me. In 1915 I visited Maleny, not far from Montville, and found a large *Stenoperla* larva fairly common there; from it I succeeded in breeding out Dr. Turner's species. Later, I both bred and captured the same species at Stanwell Park, N.S.W., and have received it from Victoria also. This species is described in the present paper, under the name *S. australis*, n.sp. (Plate xv., fig. 10).

The close relationship existing between the genera *Stenoperla* and *Diamphipnoa* is so evident that I propose, in this paper, to associate them together in a new subfamily, *Stenoperlinae*.

The genus *Eusthenia* holds an intermediate position, morphologically, between the excessively broad, clumsily-built *Thaumatoperlinae* and the slender and graceful *Stenoperlinae*. A number of new species are described in this paper. One of these, from Victoria, differs considerably from the rest in the shape of its wings and in an important venational character. I have, therefore, proposed a new genus *Eustheniopsis* for its reception. This same new genus will also include the species labelled "*Eusthenia reticulata* Klap." in the British Museum Collection.

The zoo-geographical distribution of the family is of considerable interest. *Eusthenia* is confined to Tasmania; *Eustheniopsis*, n.g., occurs in both Tasmania and Victoria; *Thaumatoperla* is only known from Victoria; *Stenoperla* occurs throughout New Zealand and the mountains of Eastern Australia, but is absent from Tasmania; and, finally, *Diamphipnoa* is found only in Southern Chili. Thus the family may be said to have had either a Notogaean or even perhaps an Antarctic origin. As the *Eustheniidae* represent the archetypic family of the Order Perlaria, the same would appear to be true of the Order. If this be granted, the present distribution of the Perlaria is easily understood. For, as the Stone-flies spread northwards through Central America to Holarctica, the three oldest families, *Eustheniidae*, *Austroperlidae* and *Leptoperlidae*, were left behind, so that nothing but comparatively specialised forms is to be found in the Northern Hemisphere.

The distribution of the family certainly presents a strong argument in favour of the Antarctic Theory. For the *Stenoperlinae* are represented in Australia, New Zealand and Chili, and nowhere else in the world. Such a distribution is scarcely to be explained on any other hypothesis.

All three subfamilies are represented in the ranges of Southern Victoria, which may therefore be regarded as the headquarters of the family.

Family EUSTHENIIDAE.

Key to the Subfamilies.

1. Wings very short and broad, the forewing less than twice as long as broad: M_5 in forewing very strongly formed, making an acute angle with M_{1-4} distally. Costa of forewing strongly dilated basally. Branches of Rs arising from R as a pectinate series of apparently separate sectors.
THAUMATOPERLINAE, n.subfam.
Wings not exceptionally short and broad, the forewing always more than twice as long as broad. M_5 less strongly formed, making either a right angle or an obtuse angle with M_{1-4} distally. Costa of forewing not dilated basally. Branches of Rs in forewing dichotomic, arising normally from Rs 2

2. Stoutly built insects of red or purple colouration, the forewing less than thrice as long as broad. Cerci long, from 12 to 16 mm.,
EUSTHENIINAE, n.subfam.
Much more slenderly built insects of green, yellow, brown or grey colouration, the forewing about five times as long as broad. Cerci short, from 5 to 8 mm.
STENOPERLINAE, n.subfam.

Subfamily THAUMATOPERLINAE, n.subfam.

Genus THAUMATOPERLA, n.g. (Plate xi., fig. 1.)

Characters as given in the key for the subfamily, with the following additions:—*Antennae* with fifty or more joints, the basal joint much enlarged. *Maxillary palpi* five-jointed, the basal joint a mere ring, the other four broad and flattened, the second being very short, the third longer, broad and femur-like, the fourth longer and narrower, the distal joint shorter and narrower still, with rounded apex. *Labial palpi* three-jointed, the basal joint very short, the second fairly long, broad and flat, the third shorter and narrower, with rounded apex. *Pronotum* more than half as wide again as long. *Legs* with the femora very broad and strongly built, the tibiae long and rather slender, the tarsi hairy, the third joint long and club-shaped, carrying strong claws and a well developed empodium. *Abdomen* about as long as forewing, broad and rather flattened; the *cerci* stoutly built, of moderate length, with at least fifteen joints.

To the venational characters given for the subfamily may be added the following:—In the *forewing*, the dilated basal portion of the costal space is free of cross-veins for a short basal space, but distally from this it carries a double row of cellules. The "apparent" sectors of the radius are three to four in number, very irregular in form and position. M is completely fused with R basally for more than one-fourth of the wing-length; immediately on leaving R, it divides into M_{1-4}, descending obliquely across the middle of the wing, parallel to the radial sectors, and into M_5, a very stoutly formed vein running quite transversely across the wing, at right angles to R+M, to join Cu_1 just distad from its origin from Cu, and thus forming a very conspicuous cubito-median Y-vein, of which the upper arm is more than twice as long as the lower. Cu and 1A are fused basally for about half the distance that R and M are fused. After junctioning with M_5, Cu_1 is a strong convex vein; it has a long distal fork. Cu_2 remains concave and lies for the most part in the cubito-anal groove, but its distal end is free from this groove, lying anterior to it. 1A, immediately after leaving Cu, is connected with 2A by a strongly formed transverse vein at right angles to it; 1A is a convex, wavy vein, with a short distal fork. 2A and 3A are both irregularly wavy, forked veins.

In the *hindwing*, the dilatation of the base of the costa is quite evident, though smaller than in the forewing. Sc is forked distally. There are three or more "apparent" sectors of R, very irregular in form and position. M is not fused with R basally, but can be seen as a very weak concave vein running below it. M_5 is strongly formed, arising from M at an agle of about 60° with M_{1-4}. Cu_1 is unbranched, diverging distally from Cu_2 so as to carry a double row of cells between them for the distal third of their lengths. Cu_2 lies in the cubito-anal furrow, except for a very short apical portion. 1A arises separately from Cu but very close under it; it gradually approaches Cu, and then fuses with it in the anal furrow for a considerable distance near the middle of the wing, finally diverging from it again. 2A is forked not far from the base, and 3A has numerous branches on the anal fan. The cubito-anal furrow divides the wing into approximately two equal halves longitudinally; the contour of the distal half of the wing, from the apex of Sc to the posterior angle of the anal fan, is very nearly semi-circular.

Genotype, *Thaumatoperla robusta*, n.sp., from Warburton, Victoria.

Apart from certain very evident specialisations in the wing-venation, this remarkable genus is perhaps the most archaic type of Stonefly at present existing, and might in many respects be regarded as a true Protorthopteron. It seems quite likely that a careful study of some of the large Protorthoptera of the Upper Carboniferous, especially those from Mazon Creek, may reveal a close affinity with this genus. Characters evidently of great antiquity in the venation are the very strong development of M_5 and the strong formation of the cubito-median Y-vein; also the primitive condition of Cu_2, which has not yet fully aligned itself into the cubito-anal groove of the wing. The well marked but irregular cross-venation, which is equally in evidence over all parts of both wings, appears to be a true archedictyon of Palaeodictyopterous or Protorthopterous origin and a feature of great antiquity. The genus is also far more archaic than any other known Stonefly in having about one-half of the area of the hindwing occupied by the veins above the cubito-anal furrow. There is also the same marked tendency towards variation in the details of venation which is found in other archaic insects, such as the Cockroaches; and this variation is particularly noticeable in comparing the two sides of the same insect.

A high specialisation of the venation is to be seen in the remarkable formation of the branches of the radius, which compares closely with that seen, in the forewings only, in the family *Hemerobiidae* of the Order Planipennia. It would appear that the true radial sector has become completely fused with the main stem of R, so that its branches come off as separate sectors. In such a case, it is usual to call these branches "apparent" radial sectors, and to state their number. Other specialisations are the great amount of fusion of R and M basally in the forewing, the fusion of Cu with 1A basally in the same wing, and a curious formation to be seen in the left hindwing only, in which the most basal of the "apparent" radial sectors has quite lost its connection with R, and is attached to M. In the right hindwing, a strong oblique cross-vein indicates the manner in which this vein-capture has been brought about.

The characters of this genus are perhaps so distinct as to justify the formation of a separate family for its reception. I have, however, determined to keep it for the present within the *Eustheniidae*, as the genus *Eustheniopsis*, n.g., is its nearest ally, and the only genus with which it shows any real affinity.

It seems most remarkable that so wonderful an insect as this should have remained unnoticed and undescribed for so many years. Though the specimen is undated, it is evidently of considerable age. It is fortunate that the Upper Yarra at Warburton still remains comparatively untouched by the growth of Melbourne, so that there are reasonable hopes of further specimens of this fine insect being discovered, and its life history being worked out.

THAUMATOPERLA ROBUSTA, n.sp. (Plate xi., Fig. 1.).

♀. *Total length*, 29 mm., *abdomen* (dried), 17 mm., *forewing*, 22 mm., *hindwing*, 20.5 mm., *expanse*, 47 mm.

Head shiny black above, with a small yellowish spot on each side of the frontal suture, just below and inwards from the base of the antenna; a transverse narrow band of olive greenish on the labrum, and a slight touch of yellowish brown on mandibles and maxillae; genae orange brown; labium dull brownish. *Eyes* dark olive grey. *Antennae* 17 mm. long, black, composed of fifty or more joints.

Thorax: *Pronotum* rich orange, the convex anterior border somewhat darkened; length of pronotum, 4.5 mm., breadth, 7.5 mm., the latter greatest anteriorly; *prosternum*, yellowish grey. *Meso-* and *metathorax* black, with a band of pale brown between the bases of the forewings; this colour extends on to the basal dilated portion of the costal space of the forewings, and carries golden hairs on both the thorax and wings. *Legs* black, the fore femora pale brown on anterior border and part of underside; the middle and hind femora with these same parts coloured more greyish yellow. *Wings* uniformly dull blackish, except for the small patch of pale brown at base of costal space of forewings, already mentioned.

Abdomen broad, nearly cylindrical, somewhat flattened, black. *Cerci* (apparently with some distal joints missing), with 15 or more short joints, the basal ones shorter than the more distal, and all carrying cilia; colour black.

Type: Holotype ♀, Collection of the National Museum, Melbourne, Victoria.

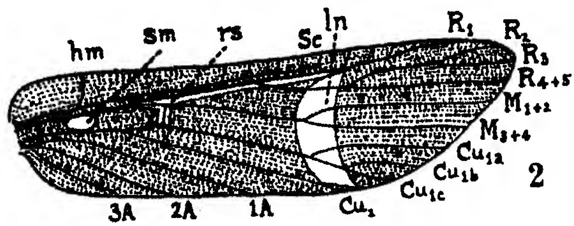
Hab.—Warburton, Victoria.

Subfamily EUSTHENIINAE, n.subfam.

Characters as given in the Key on p. 224.

The type of markings found on the wings of the *Eustheniinae* is a great help in distinguishing the rather closely allied species. In the forewing (Text-fig. 2), attention must be paid to the following markings:—Situated transversely across the wing, at about two-thirds from the base, is the very prominent pale *lunule* (*ln*), which may be narrow or wide, and either clearly delimited both distally and basally, or somewhat indistinctly outlined basally. Along the radius, from below the humeral cross-vein (*hm*) to the apex of the lunule, there is sometimes present a red stripe, called the *radial stripe* (*rs*), which may or may not send out a short downward prolongation covering M_5, as shown in Text-fig. 2. Below the humeral cross-vein, in the basal space between R+M and Cu, there is sometimes present a pale oval mark called the *subhumeral oval mark* (*sm*). It is also important to note whether the main veins are dark, or outlined in a pale colour on a darker background; in the latter case, the wing has the appearance called *reticulated*. In the hindwing, there is always a bicolorous pattern, the wing being divided into a *basal area*, nearly always bright red, but some-

times purple, and a *marginal area*, usually grey-black, but sometimes purple. If the division between these two areas is a definite clear-cut line, it is said to be *eulegnic;* if it is irregular and diffuse, then it is called *dyslegnic;* these terms being those originally proposed by Professor Poulton for similar conditions in the wings of butterflies.



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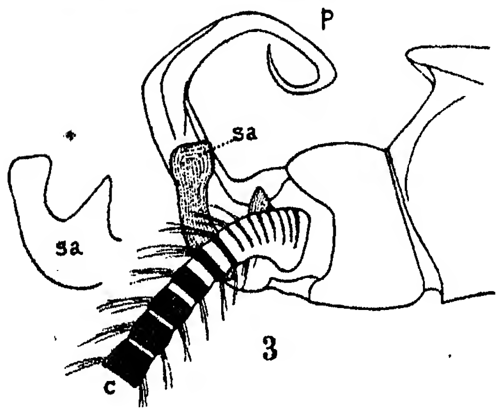

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Text-fig. 2.—Diagram of the markings on the forewing in the genus *Eusthenia*. *hm*, humeral veinlet; *ln*, lunule; *rs*, radial stripe; *sm*, subhumeral oval mark.
Text-fig. 3.—*Eusthenia lacustris*, n.sp., ♂. Anal appendages of male, lateral view (x 20). *c*, cercus; *p*, penis; *sa*, superior appendage.

The males of the subfamily *Eustheniinae* have a peculiar specialisation not found in the *Stenoperlinae*, in that the penis is greatly elongated and curved up over the tenth tergite. This condition is shown in Text-fig. 3. In pairing, the male clings to the back of the female, but brings the tip of his abdomen round under hers, so that this upcurved and dorsally coiled penis can be used to advantage. The penis is grooved, and the sperm masses are worked by it into a true spermatophore, which is held in the end-loop of the penis. How fertilisation is actually effected I have not been able to see, but it would appear to be done by simple transference of the spermatophore into the vagina of the female. In this connection, it is interesting to note also the lack of specialisation of the vulva of the female. In most Stoneflies this is a definitely projecting and often strongly bifid process; but in the *Eustheniinae* the distal border of the ninth sternite forms only a very slight undivided process. By strong muscular action, the female is able to compress her end segments laterally, giving a wide gape between the ninth and tenth sternites; and this evidently facilitates the process of fertilisation.

The form of the superior appendages of the male (Text-fig. 3, *sa*), and also of the basal joints of the cerci (*c*), are valuable specific characters in the *Eustheniinae*. Unfortunately, females are more commonly met with than males, and my series of the latter is so incomplete that I am unable to use these characters in the Key to the species. I have, however, given a description of them under each separate species, where the males are known to me.

Key to the Genera.

Wings short and very broadly round at apices, the amplitude of the hindwings very great. Forewing with a very strong reticulation of pale main veins and cross-veins on a darker ground; the costal series of veinlets abundant, without any break after the humeral veinlet .. .. EUSTHENIOPSIS, n.g.
(Genotype, *E. venosa*, n.sp.)

Wings longer, less broadly rounded at apices, the hindwings more subtriangular in shape. Forewing with the pale reticulation either less strongly developed or entirely absent; the costal series of veinlets much fewer in number and more widely spaced, especially after the humeral veinlet, where there is usually a more or less lengthy gap .. .. EUSTHENIA Westwood
(Genotype, *E. spectabilis* Westwood.)

Genus EUSTHENIA Westwood. (Plates xi.—xiii., Figs. 2—6.).

Characters as given in the generic key above, to which may be added the following:—Antennae somewhat shorter than the forewings, the basal joint enlarged. Costal space of forewing slightly widened basally, the costal veinlets widely spaced basally, but closer together distally; usually there is a considerable gap between the humeral veinlet and the next costal veinlet, which is frequently placed nearly up to the level of the origin of Rs. In the hindwing, the costal space is not noticeably widened, and there is always a long gap between the humeral veinlet and the next costal veinlet. In the forewing, M diverges from R at about one-third from base, Rs from R at about half-way; Rs has three or four branches. M_5 is well developed in both fore and hind wings, and forms a well marked cubito-median Y-vein with Cu_1, the two arms of the Y being generally about equal in length. Cu_1 in forewing has either two or three distal branches arching up anteriorly from the line of the main vein itself; Cu_2 lies entirely in the anal furrow. Forewing with three anal veins, usually unbranched. In the hindwing, Rs is fused with M basally for a very short distance in the region of the origin of M_5; Rs has either two or three branches; Cu_1 is simple. 1A is weakly formed, and lies very close to Cu_2, with which it is almost fused at about the middle of its length. 2A forks near its origin, and again at or before half-way. 3A sends five or more straight branches into the anal fan, which occupies more than half the total breadth of the wing. Cerci long, many-jointed, varying from somewhat longer to somewhat shorter than the length of the abdomen.

Genotype, *Eusthenia spectabilis* Westwood.

Key to the Species.

1. Wings rich purple, except only the large whitish lunule on the forewing and the red basal third of the hindwing. .. .. *E. costalis* Bks.
   Wings mostly dark greyish or blackish; purple only along costa of forewing; basal portion of hindwing red 2
2. Lunule of forewing broad, from 2.5 mm. to 4 mm. wide, its basal border not usually as distinctly formed as its distal 3
   Lunule of forewing narrow, from 1 mm. to 1.5 mm. wide, with both basal and distal borders clearly defined 4

3. A red radial mark of full length in forewing; the same wing with pale reticulation more or less clearly outlined on all the main veins and cross-veins. *E. spectabilis* Westwood
   No red radial mark in forewing, and no pale reticulation except on the cross-veins beyond the lunule .. .. *E. purpurescens*, n.sp.
4. Forewing with pale reticulation of main veins and cross-veins; a definite, whitish subhumeral oval mark present on forewing .. .. *E. lunulata*, n.sp.
   Forewing without any pale reticulation, the main veins and cross-veins entirely dark; no subhumeral oval mark present .. .. *E. lacustris*, n.sp.

EUSTHENIA SPECTABILIS Westwood.

Westwood, in Griffith's "Animal Kingdom," Insects, vol. ii., 1832, p. 348, Pl. lxxii., fig. 4.

Newman, "On the synonymy of the Perlites . . ." Mag. Nat. Hist., New Series, vol. iii., 1839, p. 33.

From Newman's short description we learn that this species had on the forewing, "an elongated red spot near the costal margin" and "beyond and below this a large blotch of dirty white," while the hindwings were "red at the base and black externally." These details would scarcely be enough, by themselves, to determine which of the Tasmanian species was really *E. spectabilis*. But, taken in conjunction with a study of the British Museum series of specimens, they enable us to define the species more accurately.

In the British Museum there are four specimens arranged together under the name "*spectabilis*." The first three of these are conspecific, the fourth is quite distinct. The first specimen bears a label "*E. spectabilis*" and appears to be the type. This and the two following specimens agree with Newman's definition, the red radial stripe being clearly present, and the lunule broad and distinct; in the hindwing, the division between red and grey-black is somewhat dyslegnic, and ends on the costa about half-way. The fourth specimen has no radial stripe, the costal space of the forewing being purpurescent throughout; it differs further from the other three specimens in having the subhumeral oval mark present, in the very dyslegnic division between red and black on the hindwing, with the red tending to spread out distally along the costa, and also in having an exceedingly wide lunule on the forewing.

True E. *spectabilis* may now be defined as follows:—Pronotum with a brownish anterior lobe, distinctly convex, with very distinct sculpture of an arabesque type, slightly raised above the ground level. No subhumeral oval mark on forewing. Radial mark of forewing typically reaching from beneath humeral veinlet to above top of lunule, with a slight downward prolongation on M_5. Lunule fairly well defined, about 2.5 mm. wide, and not completely crossing the forewing. Division between red, and black on hindwing somewhat dyslegnic, ending on costa about half-way. The pale reticulation is present on main veins and cross-veins of forewing, being only moderately well outlined in pale grey.

N. Banks states that, in the male of *E. spectabilis*, "the superior appendages are widened at the tip and acute on the inner side." The specimen named *E. spectabilis* by Banks in the Hope Museum, Oxford, is, however, not that species, but is conspecific with the fourth specimen in the British Museum series (=*E. purpurescens*, n.sp. of this paper). As I have no males of *E. spectabilis*, but possess one of *E. purpurescens*, in which the male appendages do not fit this description, it is to be assumed that Banks' remarks do actually apply to the male of *E. spectabilis*.

Type, in British Museum Collection.

Hab.—Tasmania, chiefly in the south (Hobart).

EUSTHENIA SPECTABILIS EULEGNICA, n. subsp. (Plate xiii., Fig. 4.).

I have in my collection a very fine female from Tyenna, Tas., which is clearly closely related to typical *E. spectabilis,* but differs in two important points. The radial mark of the forewings is exceptionally well developed, and sends downwards a strong prolongation covering M_3; also the amount of red on the hindwing is greater, and the division between red and black is eulegnic. *Expanse,* 51 mm., *cerci* 12 mm. long. The locality from which this comes is within the new Tasmanian National Park, at over 1000 feet elevation. It appears well worthy of subspecific rank.

Type: Holotype ♀, in Tillyard Collection, Cawthron Institute, Nelson, N.Z. Taken by C. E. Cole, 29.12.1916, at Tyenna, Tasmania.

EUSTHENIA PURPURESCENS, n.sp. (Plate xiii., Fig. 6.).

♀. *expanse* 52 mm. Allied to *E. spectabilis,* from which it may be at once distinguished by the following characters:—Pronotum with the front and hind borders brown, the former straight in the middle, not so regularly convex as in *E. spectabilis.* Cerci with the basal joints shorter and less strongly ciliated. Forewings without any radial mark; the costal space is purpurescent, with the radius darkly shaded in grey-black; the subhumeral oval mark is present, whitish touched with purple, and followed distally by a blackish patch attached below R and then descending obliquely along Cu; the lunule has a rather irregular basal outline, and is widest anteriorly where it ends just beneath R. There is no reticulation of the main veins in pale outline, but the cross-veins beyond the lunule are so marked. In the hindwing, the division between red and purplish black is somewhat dyslegnic, and is very distinctly angulated on the vena dividens (Cu_2).

♂, *expanse* 41 mm.; *cerci* 16 mm. long, black, downy, with short, weak cilia, basal joints stout, not as long as wide; *superior appendages* short, tips somewhat blunt. Colouration as in ♀.

Types: Holotype ♀, and allotype ♂ in Tillyard Collection, Cawthron Institute, Nelson, N.Z. Taken by G. H. Hardy, 6.12.1913, at Hobart, Tasmania.

Hab.—Tasmania, chiefly in the south.

EUSTHENIA PURPURESCENS EXTENSA, n.subsp.

A fine female taken by Mr. C. E. Cole at Russell, Tasmania, on Dec. 26th, 1916, differs from the type in having the red colour of the hindwing spreading distally far along the costa, the subhumeral oval mark of the forewing not so clearly indicated, the pale reticulation present, but weakly formed, on all parts of the forewing, and the lunule not quite so wide anteriorly. This form appears to be a good subspecies.

Type: Holotype ♀, in Tillyard Collection, Cawthron Institute, Nelson, N.Z.

As Russell is not far from Tyenna, it appears that, in the elevated National Park area, each species known from the Hobart district is there represented by a distinct subspecies.

EUSTHENIA LUNULATA, n.sp. (Plate xii., Fig. 3.)

♀, *expanse* 48 mm. Allied to *E. spectabilis,* with which it agrees in general colouration and appearance, but differs in the following important points:—Pronotum dark olive, the anterior border not marked with brown, the arabesque sculpture intricate, dissimilar from that of *E. spectabilis.* Forewings with the pale reticulation moderately well marked everywhere except along the costal

space; a considerable gap between the humeral veinlet and the next costal veinlet, which arises just before the origin of Rs. Subhumeral oval mark small but well defined. Radial red mark very small, beginning beyond the point of departure of M from R+M, and ending just before the level of the lunule. Lunule very distinct, whitish, very narrow (barely 1.5 mm. wide), forming a very distinct crescent, not touching R. In the hindwings, the division between red and grey-black is eulegnic, beginning about half-way along the costa, then proceeding downwards at right angles to the costa as far as the vena dividens, where it bends sharply round, leaving an amount of marginal black on the anal fan almost as wide as the greatest width of the red.

♂, expanse 36 mm. *Cerci* 10 mm. long, black with rings of pale brown cilia, basal joints longer than wide. *Superior appendages* bluntly rounded at apices, with a strong, short spine at outer distal angle. Closely resembling the female, but differing in its much smaller size, and in having the distal border of the lunule not quite so regular, and the lunule itself slightly wider in comparison with its length.

T y p e s: Holotype ♀ and allotype ♂ in Tillyard Collection, Cawthron Institute, Nelson. Both taken at Cradle Mountain, Tasmania, altitude about 3000 feet, the female on January 21st, the male on Jan. 23rd, 1917. Also a paratype ♀ from same locality, Jan. 23rd, 1917.

Hab.—Only known from the streams around Cradle Mountain at high elevations.

EUSTHENIA LACUSTRIS, n.sp. (Plate xii., Fig. 5.)

♀, expanse 47 mm. A very distinct species, easily recognised by the following characters:—The whole body shining black; femora black, the tibiae and tarsi brownish. Forewings brownish black with black veins showing up clearly; pale reticulation entirely absent; costal space purple, the same colour extending beyond the lunule right to the apex; base of wing for about 2 mm. is also purplish, and this colour just reaches the very indistinct subhumeral oval mark. Lunule whitish, very clearly defined, narrow (about 1.5 mm. wide), not quite reaching the posterior margin of the wing, and confluent above with the radial mark; this latter is very strongly developed, bright red, and confluent with the whole width of the lunule distally; it also sends a strong transverse prolongation downwards covering the whole of M_5. Hindwings with the division between red and black moderately eulegnic, shaped as in *E. lunulata*, but with the red occupying a larger area of the base of the wing.

♂, *expanse* 39 mm. *Cerci* 12 mm., black, strongly ciliated, basal joints about as wide as long. *Superior appendages* blunt at tips, and each carrying on its basal half inwards a strongly projecting spine. Closely resembling the female, but with the red of the radial mark extending anteriorly on to the costa. A lateral view of the appendages is shown in Text-fig. 3.

T y p e s: Holotype ♀ and allotype ♂, in Tillyard Collection, Cawthron Institute, Nelson, N.Z. (taken *in cop*, Lake Lilla, Cradle Mountain, Tasmania, Jan. 12th, 1917); also a series of paratypes of both sexes, taken around Cradle Mountain in the same month.

Hab.—Lakes Lilla and Dove, and Crater Lake, Cradle Mountain, about 3200 feet, Tasmania. This is the only species known to me whose larva inhabits the still water of lakes. All the others live in the fast running mountain torrents.

This species is probably most closely allied to *E. lunulata*, with which it agrees in the narrow form of the lunule, but can be at once separated from it by

the absence of pale reticulation on the forewing, the strong development of the radial mark, and the greater amount of red on the hindwing.

EUSTHENIA COSTALIS N. Banks. (Plate xi., Fig. 2.)

Banks, "Synopsis and Descriptions of Exotic Neuroptera." Trans. Amer. Ent. Soc., xxxix., 1913, p. 204.

There is a single male of this very beautiful species in my collection, taken at Cradle Mountain. This has been compared with Banks' type. The short description given by Banks may now be supplemented as follows:—

♂, expanse 43 mm. *Cerci* 14 mm. long, dark brown, strongly ciliated, with basal joints very short, much wider than long. *Superior appendages* very short, acutely pointed. Forewings purplish, with pale reticulation weakly developed on the anal area and on the cross-veins beyond the lunule. Subhumeral oval mark very distinct, pale yellowish. No red radial stripe present. Lunule whitish tinged with purple, very clearly defined, about 2.8 mm. wide, nearly reaching the costa, and ending posteriorly on the wing border 2 mm. wide. Hindwings with the basal part orange red, this colour extending to about half way on the costa, but much less in other directions; by far the greater area of the wing is a beautiful purple. The division between red and purple is strongly dyslegnic, the purple encroaching irregularly on the red.

Type: Holotype ♂ in Museum of Comparative Zoology, Cambridge, Mass, U.S.A. (Taken by A. M. Lea at Magnet, Tasmania).

Hab.—High elevations in North Western Tasmania.

Genus EUSTHENIOPSIS, n.g. (Plate xiv., Fig. 7.)

Characters as given in the Key on p. 228.

Genotype, *E. venosa*, n.sp.

Distribution:—Tasmania and Southern Victoria.

Key to the Species.

Basal area of hindwing purple: pronotum normal .. .. *E. venosa*, n.sp.
Basal area of hindwing red: pronotum with raised lateral edges and strongly projecting antero-lateral angles .. .. *E. reticulata* Klap. MS.

EUSTHENIOPSIS VENOSA, n.sp. (Plate xiv., Fig. 7.)

♀, expanse 40 mm. Pronotum dark grey, bordered in front and behind with brown. Fore femora with a pale yellowish ring apically. Forewings dark brown, with very strong and distinct pale reticulation of all the main veins and cross-veins; a small amount of similar reticulation is also to be seen near the apex of the hindwing. In the forewing, the costal veinlets number about twenty. Subhumeral mark present, whitish; another small squarish blotch of the same colour covers M_5. No red radial stripe present. Lunule exceedingly narrow (little over 1 mm. wide in middle), and with both borders irregular; it reaches from Sc to the posterior margin of the wing. Hindwings with the basal three-fifths *purple*, the area occupied by this colour being squarish, strongly angulated on the vena dividens, and with its border somewhat concave above this angle. Rest of hindwing dull greyish-black, the division between purple and black eulegnic.

Type: Holotype ♀ in the collection of the National Museum, Melbourne, Victoria (labelled "Narracan, 1.94"). A second specimen from the same locality is in the Cawthron Institute Collection, Nelson, N.Z.

Hab.—Victoria.

EUSTHENIOPSIS RETICULATA Klap. MS.

In the British Museum Collection there is a single specimen carrying a label "*Eusthenia reticulata* Klap." I can find no record of any published description of this insect by Klapalek, and I assume that he must have studied the insect and attached the MS name to it, but that his description has never been published. I propose, therefore, to retain the name *reticulata* given by him, and to indicate the special characteristics of the species.

Pronotum with strong lateral ridges and strongly marked antero-lateral angles. Forewing with all the main veins and cross-veins strongly outlined as a pale reticulation. Subhumeral oval mark completely swallowed up in a large whitish basal patch, which is followed distally by a dark subrectangular patch. There is no red radial stripe on the forewing. Lunule rather narrow, very distinct, stretching right across the forewing. Hindwing red basally, blackish distally, the division between the two colours being eulegnic, and beginning well beyond half-way along the costa.

In general shape and appearance, this insect strongly resembles *E. venosa*, particularly in the short, strongly rounded wings, and in the very strongly marked pale reticulation. It differs, however, in the remarkable form of the pronotum, and in having the basal area of the hindwing red instead of purple.

T y p e: Holotype ♀ in British Museum Collection.

Hab.—Tasmania.

Subfamily STENOPERLINAE, n.subfam.

Characters as given in the Key on p. 224.

Key to the Genera.

Very large insects, expanding 80 mm. or over; antennae nearly as long as forewing; pronotum half as wide again as long; costal series of veinlets complete and abundant in fore and hind wings; cross-veins between M and Cu_1 in forewing all connected by short cross-bars, so as to form two rows of cellules.
DIAMPHIPNOA Gerst.
Genotype, *D. annulata* (Br.)

Moderately large insects, expanding from 50 to 70 mm.; antennae from one-half to two-thirds as long as forewing; pronotum somewhat heart-shaped, about as wide as long; costal series of veinlets few and incomplete, there being always a long gap between the humeral veinlet and the next one; cross-veins between M and Cu_1 in forewing normal, forming only a single row of cellules, only occasionally connected by a cross-bar .. .. STENOPERLA McLach.
Genotype, *S. prasina* (Newm.).

Genus STENOPERLA McLach. (Plate xv., Figs. 9, 10.)

Characters as given in the generic key above.

G e n o t y p e, *Stenoperla prasina* (Newman).

Key to the Species.

Forewings bright green, hindwings pale, tinged with green. New Zealand.
S. prasina (Newm.)

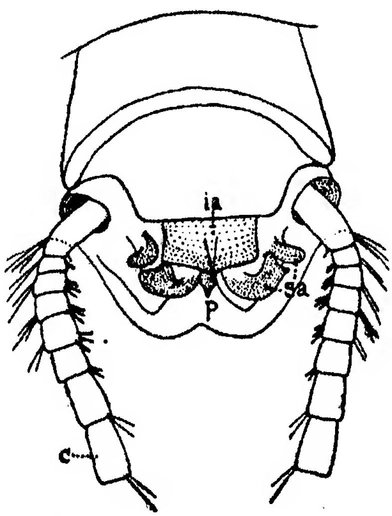
Forewings mottled grey, hindwings tinged with orange pink basally and on anal fan, mottled grey distally. Australia .. .. *S. australis*, n.sp.

STENOPERLA PRASINA (Newman). (Plate xv., Fig. 9.)

Newman, Zoologist, vol. iii., 1845, p. 852 (under *Chloroperla*).

This well known insect is quite common in many parts of New Zealand though in places its numbers have been greatly diminished by the introduced trout, of which the larva forms a favourite food.

There is considerable variation in details of the venation, such as the number of costal veinlets, the number of branches of Rs and Cu_1 in forewing, and the condition of the space between Rs and M in both wings; this latter space is usually free from cross-veins in its basal half, but occasionally has one or more present there. The tracheation of the larval wing of this species is shown in Text-fig. 1. The cerci and anal appendages of the male are shown in Text-fig. 4. It should be noted that the short basal joints of the cerci, in this sex, carry, on the inner side, sets of from one to three short strong bristles, and, on the outer side, longer and slenderer hairs. The superior appendages and penis are up-



Text-fig. 4.—*Stenoperla prasina* (Newman), ♂. Anal appendages of male, ventral view (x 20). *c*, cercus; *ia*, inferior appendage; *p*, penis; *sa*, superior appendage.

curved, but much shorter than in the *Eustheniinae;* the former are broad and slightly widened at the apex, and carry basally on the inner side a very distinct process with a rounded tip; the penis is somewhat shorter than the appendages, its apex more pointed.

An interesting variety of this species occurs occasionally, in which the green colour is entirely replaced by yellow. The forewings, in the specimens which I have seen, are generally somewhat shorter than in typical specimens, but I can find no other morphological differences.

Type in British Museum Collection.

Hab.—The whole of New Zealand, in the neighbourhood of fast running streams.

STENOPERLA AUSTRALIS, n.sp. (Plate xv., Fig. 10.)

♂, *expanse* 54 mm. Head dark grey, marked with brown on epicranium; *eyes* black; *antennae* 11 mm. long, dark brown, basal joint much enlarged, second joint very short, slightly wider than third, which is rather long and cylindrical; mouth-parts and underside of head bright orange brown, palps dull grey-brown.

Thorax: *Pronotum* dark grey, brown along anterior border. *Meso-* and *metathorax* shiny brownish. *Legs* dark grey touched with brown.

Abdomen (shrivelled) dark brown. *Cerci* 5 mm. long, black with pale brown cilia, the basal joints somewhat shorter than wide. *Superior appendages* upcurved, dark brown, the outer border convex, the tips hard, black, inclined inwards. *Penis* a little longer than appendages.

Type: Holotype ♂, taken by Dr. A. J. Turner at Montville, Blackall Ranges, Queensland, Oct. 5th, 1912; in Tillyard Collection, Cawthron Institute, Nelson, N.Z. In the same collection there are also a male bred from a larva taken at Maleny, near Montville, by myself, on Nov. 28th, 1915, and a larger specimen, expanse 60 mm., probably a female, but with abdomen missing, taken by Mr. G. Lyell at Stanwell Park, N.S.W., on April 22nd, 1916. Another specimen labelled "Victoria, Whittlesea" is in the Collection of the National Museum, Melbourne.

Hab.—Fast mountain streams in Eastern Australia, but not Tasmania. The larvae exuviae are common objects on the rocks in the streams of the Blue Mountains, N.S.W., but the perfect insect is seldom seen, as it flies but little.

Genus DIAMPHIPNOA Gerst. (Plate xiv., Fig. 8.)

Characters as given in the generic key on p. 233. The imago has four pairs of abdominal gills, on segments 1—4, carried over from the larva. I think this carrying over of abdominal gills in the imago occurs in all the *Eustheniidae*, as I have certainly seen them in newly-emerged specimens of *Eusthenia lacustris* and *Stenoperla australis;* but they very soon shrivel up, so as not to be clearly discoverable in mature specimens. Probably the great size of the species *D. annulata* makes it possible, in this case, to see these delicate organs more clearly in the imago.

Genotype, *Diamphipnoa annulata* (Brauer).

DIAMPHIPNOA ANNULATA (Brauer). (Plate xiv., Fig. 8.)

Stenoperla annulata, Brauer, Verhandl. zool.-bot. Gesell. Wien, xix., 1869, p. 17. Chili.—*Diamphipnoa lichenalis,* Gerst., Festschr. nat. Freunde, 1873, p. 64, fig. 17.

There is a magnificent specimen of this fine insect in the Hope Museum at Oxford. *Forewing,* 44 mm.; *antenna,* 35 mm.; *total length,* 28 mm.; *expanse,* 90 mm.; *cerci,* 8 mm. The general colour is grey, the forewings grey with dark brown veining and irregular clouding of brown along the cross-veins, especially at each end where they join with the main veins; the hindwings paler grey, with brown veins, and clouding of darker grey at ends of the veinlets along distal half of costal border. The specimen is a female, labelled "Chili, 1860." The photograph shown in Plate xiv., fig. 8, is taken from this insect.

Cawthron Institute, Nelson, N.Z., 12.3.1921.

EXPLANATION OF PLATES XI.—XV.

Plate xi.

Fig. 1. *Thaumatoperla robusta*, n.g. et sp., ♀. (x 2.7).

Fig. 2. *Eusthenia costalis* N. Banks, ♂. (x 2.7).

Plate xii.

Fig. 3. *Eusthenia lunulata*, n.sp., ♀. (x 2.7).
Fig. 5. *Eusthenia lacustris*, n.sp., ♀. (x 2.5).

Plate xiii.

Fig. 4. *Eusthenia spectabilis eulegnica*, n.subsp., ♀. (x 2.7).
Fig. 6. *Eusthenia purpurescens*, n.sp., ♂. (x 2.4).

Plate xiv.

Fig. 7. *Eustheniopsis venosa*, n.g. et sp., ♀. (x 2.7).
Fig. 8. *Diamphipnoa annulata* (Brauer), ♀. (Hope Museum, Oxford). (x 1.4).

Plate xv.

Fig. 9. *Stenoperla prasina* (Newman). ♀. (x 2.4).
Fig. 10. *Stenoperla australis*, n.sp., ♂. (x 2.3).

Photographs for Figures 1, 2, 5 and 7 were taken by Mr. J. Tutcher of Bristol England; for Figures 3, 4, 6, 9 and 10 by Mr. W. C. Davies, Curator of the Cawthron Institute, Nelson; Figure 8 was sent to me by Professor E. B. Poulton, F.R.S., Hope Professor of Zoology, Oxford University, and was enlarged by Mr. Davies. I desire to thank all these gentlemen for the excellent series of photographs provided by them for this paper.

ORDINARY MONTHLY MEETING.

29th June, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Mr. Horace William Brown, Reid Park, Mosman, was elected an Ordinary Member of the Society.

Letters were read from Mr. J. J. Fletcher, M.A., B.Sc., and Mr. R. J. Noble, B.Sc., returning thanks for congratulations.

It was resolved that the congratulations of members be conveyed to Sir Hugh Dixson on the honour of Knighthood conferred on him.

The President called the attention of members to two very useful volumes on Sweden presented by the Swedish Consul-General for Australia.

The Donations and Exchanges received since the previous monthly meeting (25th May, 1921), amounting to 10 vols., 92 Parts or Nos., 7 Reports and 9 Pamphlets, etc., received from 57 Societies and Institutions and four private donors, were laid upon the table.

NOTES AND EXHIBITS.

Mr. W. F. Blakely exhibited from the National Herbarium the following new and rare plants for New South Wales:—(i.) *Kochia Georgei* Diels. (Bot. Jahrb., xxxv., 1905, p. 184), a Western Australian plant, now recorded for N.S.W. and S.A. Mount Oxley near the Darling River (E. Betche, October 1883); Wilcannia (E. Betche, 1893); Broken Hill (J. B. Holding, Oct. 1916 and E. C. Andrews, Nov. 1917); Gawler Ranges (J. M. Black, Jan. 1913); Mt. Lyndhurst, "A perennial fodder plant 1—1½ feet high," (Max Koch, No. 190). It differs from *K. villosa* in the much larger, glabrous and broadly winged perianth, which sometimes exceeds 2 cm. in width.—(ii.) *K. villosa* Lindl. var. *microcarpa* Benth. from Zara Station, Wanganella (Miss E. Officer, No. 226, May, 1905). Apparently a rare plant as it is the only specimen from a definite N.S.W. locality in the Herbarium. It is a well-marked variety and differs considerably from the typical form.—(iii.) *Drymaria filiformis* Benth. A small wiry Caryophyllaceous plant previously recorded from the Murray River district (Mueller), and recently received from Pine Ridge, Wyalong (Alex. Cooper, Nov. 1920).

Mr. G. H. Hardy exhibited a species of *Eusthenia* from Cradle Mt., Tasmania, described as new by Dr. Tillyard.

Mr. E. Cheel exhibited a live plant of *Cosmos caudatus* H.B. et K., raised from seed collected from plants naturalised at Macnade Mill district in Queensland, received from Dr. T. Guthrie. The specimens were grown for comparison with specimens collected at Fiji in July, 1918. It is quite common everywhere in

Fiji and, so far as can be ascertained, has not previously been recorded for the Fijian Islands, probably being mistaken for the cultivated species, *C. bipinnatus*, from which it is easily distinguished by the longer and more scabrid slender beak which bears two slender, spreading, retrorsely scabrid awns. It is a native of the West Indies naturalised and widely distributed in the Philippines (E. D. Merrill, Fl. Manila, 1912, p. 478) where some forms, chiefly with yellow flowers, are cultivated. The ray flowers are of a pink colour, otherwise the foliage and achenes are remarkably like *C. sulphureus* Cavanilles, especially the form cultivated under the trade name "Klondyke Cosmos"; the latter flowers quite freely in our Sydney Gardens, but the pink flowering *C. caudatus* has not yet flowered successfully out of doors, as it requires a much longer season.

Mr. Fletcher showed half a pod, 4 inches long, with the seeds (two) attached, and detached seeds, of the Coral Tree, *Erythrina indica* Lam., which he had recently found on the footpath, underneath the overhanging boughs of a tree in a garden at Hunter's Hill. Inspection of the tree showed five small bunches of similar pods still attached to branches. The trees are common in gardens, but this was the first time he had seen a fruit-bearing example. The species is indigenous in East India and the Archipelago, in the islands off the north coast of Australia, and in Queensland, but not in New South Wales. Notes on the pollination of this species, of its non-fruiting in Illawarra, but of its reported fruiting in the Northern River districts, at Mulgoa, and in Queensland, are given by Mr. A. G. Hamilton, in These Proceedings, 1916, p. 26, or in two of his papers there referred to.

Mr. A. R. McCulloch, with the permission of the Director of the Australian Museum, exhibited a young example of the Frost Fish, *Lepidopus caudatus*, which was trawled recently off Botany Bay in about sixty fathoms. This is the first of the species to be recognised from New South Wales, and though only about eight inches long, differs in no important characters from an adult specimen from New Zealand.

PRELIMINARY REPORT ON THE NUTRITIVE VALUE OF CERTAIN AUSTRALIAN GRASSES.

By Margaret H. O'Dwyer, B.Sc., Science Research Scholar in the University of Sydney.

CONTENTS.

i. *Introduction.*

In this paper it is proposed to embody the results of some research work which has been carried out by myself in the Research Laboratory of the Agricultural Department in the University of Sydney. As yet the work can only be regarded as being in a preliminary stage, but it is hoped later, in further publications of the series, to discuss more fully the economic aspect of the question and to be able thereby to increase the value of the results to pastoralists and agriculturists in this State and in the Commonwealth.

In view of the amount of attention which has been given to this subject in the United States within the last two decades, it is remarkable that, in Australia, which depends so much on its pastures, the value of the native grasses should not have received greater recognition from the "Man on the Land," for experts have often drawn attention to their drought-resisting qualities, and have emphasised the value of their cultivation.

The experience which has been gained in the United States should be invaluable to us. There, also, they have suffered from the results of overstocking (Pammel, 1901), many native grasses having died out from this cause. Great efforts, however, have been made there to renew the worn out pastures by the systematic cultivation of their most valuable indigenous grasses (Lawson-Scribner, 1896; Pammel, 1901; Sampson, 1914). These pastures show continuous improvement from year to year.

Something of the same kind must be attempted in Australia at no very distant date if we are to retain the valuable heritage we possess in our native grasses. A beginning has been made, for most of the State Experiment Farms possess experimental grass plots. The enormous value of these in stimulating interest in the formation of permanent native grass pastures will be evident.

In the examination of American grasses and of feeding stuffs generally, the chemists are working in conjunction with the botanists (Griffiths, 1915; Knight, 1905, 1906, 1908, 1911). The advantages accruing from team work of this kind must be apparent to every thinking person, and it is to be hoped more of it may be done in Australia than has been the case so far.

ii. *Material.*

Through the courtesy of the Director of Agriculture, for which I am very grateful, the material has, for the most part, been sent in from the various State Experiment Farms. Any slight abnormalities which may exist as a result of cultivation on the Farms should be more than compensated for by obtaining the material in a pure state, which would be almost impossible if it were taken from the grass paddocks of an ordinary farm or station.

In every case a sample of the grass analysed has been kept, so that its identification can be verified at any time.

Stages of Growth.—On beginning this work it was found advisable, if any systematic research was to be conducted, to obtain the material in certain well-defined stages of growth. Each grass has, therefore, been procured as far as possible in—

(*a*) what is known as the medium stage, or about half-way between the time when it begins to shoot and the early flowering period. Grasses are often fed off to stock at this stage, which is said to contain the largest amount of moisture and crude protein,—the latter, however, being largely composed of amino acids and other so-called immature proteins (Armsby, 1911; Vipond, 1914), and the smallest amount of crude fibre, the percentage of which appears to increase rapidly as the grass grows older (Pammel, 1901, p. 411).

(*b*) The second stage chosen for analysis is the early flowering period. For most of the analytical work on grasses which has been done in the United States, this stage and the third stage, mentioned later, have been used (Griffiths, 1915; Knight, 1906).

(*c*) The third stage being used for analysis is that at which the seed is quite set.

Condition of Material.—Most of the analytical work has been done on the air dried material. In the first place it was found impossible to get material, which had to come any great distance, in a perfectly fresh condition. In one case, which will be referred to later, a grass arrived from Glen Innes in a wilted condition, and on being dried and analysed showed a different protein content from another sample of the same grass in the same stage, which had been dried on the Farm.

The material is weighed at the Farm as soon as cut, dried and then reweighed, the difference in weight representing the moisture content other than hygroscopic moisture. Unfortunately, none of the Farms, except Hawkesbury Agricultural College, possess even a rough chemical balance, so that inaccuracies will be found in the percentages of total moisture. At present these seem unavoidable. The material must be weighed immediately after being cut, as it begins to lose water at once.

For analytical purposes the material is ground up until it is fine enough to pass through a 1 mm. sieve (Brunnich and Smith, 1907, p. 343). It is then stored in airtight bottles and kept in the dark until required (Knight, 1906, p. 5).

iii. *The Value of Digestibility Experiments.*

In a publication entitled "The Relative Value of Feeding Stuffs—Experiments with the Respiration Calorimeter in Co-operation with the Bureau of Animal Industry" (Armsby, 1907), the writer states that the only safe basis for a comparison of the nutritive value of feeding stuffs is the actual experiment upon the animal, in which the real gain or loss of flesh and fat is accurately determined. In other words, that the only way to ascertain the nutritive effect is to actually determine it. Kellner (1909) found that, in the case of coarse fodders, the actual results were much lower than the computed ones. The difference was found by him to be very closely proportional to the amount of crude fibre present, amounting to 617 calories for each lb. of the total crude fibre. When this deduction was made, the computed results agreed very closely with those found.

Pammel, etc. (1901) give the following digestion coefficients for pasture grass:—

	Digestion Coefficients.	Digestible Ingredients.
Dry matter	69	13.8%
Organic matter	70	12.6%
Crude protein	66	2.3%
Crude fibre	74	3.0%
N free extract	73	7.1%
Ether extract	55	0.4%

The digestion coefficient is the percentage of the particular nutrient which is digested during the passage of food through the animal.

The percentage of digestible ingredients is found by multiplying the percentage of each ingredient in the substance by its digestion coefficient.

Hence if the percentage of protein in a feeding stuff is 7.4, and the digestion coefficient is .59, the percentage of digestible ingredients in the protein content of the feeding stuff will be $(7.4 \times .59) = 4.4$ (Pammel, 1901).

The figures given in the table may serve to indicate roughly, at any rate, the digestibility of similar feeding stuffs in Australia, but it is to be hoped that before long, digestibility experiments may be carried out in this State, for, without these, no completely accurate basis of the nutritive value of feeding stuffs can be arrived at.

iv. *Discussion of Methods.*

Up to the present the official methods of the Association of American Agricultural Chemists, as revised up to the end of the year 1919, have, in the main, been followed. (Assocn. of Official Agricultural Chemists, 1920.).

The principal reasons for adopting the American methods in this early stage of the work are:—

(*a*). A large amount of investigation into suggested modifications in methods has been carried out by the American Agricultural Colleges, Bureaux of Chemistry, etc. (Francis, 1916; Bidwell and Walton, 1916; Bidwell, 1916; Francis, 1919; Clarke, 1920; Phelps and Daudt, 1919), and the methods have apparently been subjected to very close scrutiny before being classed as official (Assocn. Official Agricultural Chemists, 1920, Introduction).

(*b*). Only by practically adopting the same methods, is it possible to make any comparisons between the analyses of our native grasses and those of the United States.

Certain interesting modifications of these methods, however, are of considerable value, and these I hope to make the subject of a further communication in the future. Dr. Petrie (1908), discussing those used for the precipitation of the proteins, gives an account of some preliminary experiments which he carried out with the seeds of *Acacia pycnantha*, copper hydroxide, (Stutzer's Reagent), tannin salt solution and alcohol being severally used as precipitants. He found that, apparently, alcohol and tannin salt solution gave distinctly more reliable results than copper hydroxide which is the reagent used in the official American methods. These reagents might also be used to advantage in the precipitation of the proteins in grasses. Similarly acetone has been suggested as a precipitant for the proteins (Weyl, 1910).

No attempt has been made so far in this work to examine the non-protein nitrogen in the grasses. Although Van Slyke's method (1911-12) appears at first sight to be suitable for the purpose (Grindley and Eckstein, 1916; Grindley, etc., 1915), other writers (Dowell and Menaul, 1919; Görtner, 1918; Görtner and Holm, 1917; Hart and Sure, 1916) show that furfurol and dextrose tend to react on the amino acids and protein hydrolysates (Dowell and Menaul, 1919, p. 131), and that consequently an unusually large percentage of nitrogen is found in the humin. This weakness in the method has also been noted by Grindley, Joseph and Slater (1915). From a consideration of their own results, confirmed as they were by Görtner (1918), Hart and Sure conclude that the method of direct hydrolysis for the estimation of amino acids in feeding stuffs by the Van Slyke method is inapplicable, and that the results so secured will be open to question. It is further suggested by them that, in the present unsatisfactory status of the methods for estimating the amino acids in the complex protein-carbohydrate mixture of feeding stuffs, the only reliable procedure for obtaining an insight into the nutritive worth of the proteins in such a mixture is the biological one.

All the writers mentioned above, however, as well as Nollau (1915), Kellner (1910), and Brunnich and Smith (1907), stress the great importance of the non-protein nitrogenous compounds of feeding stuffs, and especially of the amino acids. In the actual determination of proteins in the grasses, I have followed the Kjeldahl Gunning Arnold method recommended by the Association of Official Agricultural Chemists of America (1920), and have found it to work satisfactorily. Slight modifications in the official methods of estimating proteins have been suggested from time to time (Brill and Ascavili, 1917; Phelps and Daudt, 1920), the last named writers suggesting that the use of rubber stoppers in the apparatus, as in the official method, may contribute small amounts of ammonia-reacting substances, and recommending that cork stoppers, entirely covered with tin foil, be used instead. In the determination of true protein, or albuminoid nitrogen, Stutzer's Reagent has been employed as a precipitant for the proteins (Assocn. Offic. Agric. Chemists, 1920).

Crude Fibre.—The acid-alkali method has been used in estimating the crude fibre in the grasses (Assocn. Offic. Agric. Chemists, 1920). Although the method may have many drawbacks (Bidwell and Walton, 1916; Francis, 1916), it is usually considered superior to other methods.

Bidwell and Walton (1916) point out that crude fibre is not the name of a definite substance, but only a convenient and somewhat descriptive term used to denote the result obtained by treating a feed by the official method. "Inasmuch," they say, "as crude fibre designates simply a numerical value obtained by following the official method which is strictly an empirical one, any devia-

tion therefrom will give incorrect results. This is the strongest and all important objection to any material change in a method for official endorsement" (1916, p. 34). These writers have found that, by observing certain precautions, the results of the official method will check very closely, and the difficulties and tediousness will be eliminated. In fact, they have been unable to make the determination by any of the proposed modifications in any less time than by the official method. J. A. and E. W. Voelcker (1918) recommend a modification of the official method involving the use of a 2% solution of the acid and alkali instead of the 1.25% solution used by the American chemists. Brunnich (1907) is of the opinion that König's method (1898) is superior to the acid alkali method, and that the resulting crude fibre is free from pentosans. König's method has, however, been unfavourably criticised by American chemists, on account of its slow filtration and because of the variation in duplicates. Brunnich, however, claims to have overcome these defects (Brunnich and Smith, 1907). In a publication entitled "The Feeding Value of Cereals, as calculated from Chemical Analyses" Chamberlain (1909) states that crude fibre, though only slightly digestible, plays a very important part in digestion. "It acts as a dilutant," he says, "of the more concentrated portions of the food, such as starch; necessitates for the whole food thorough mastication and prevents it from becoming too compact; in other words it keeps the food mass porous and open to the action of digestive fluids. If, however, the crude fibre is in excess, the amount of energy expended by the animal in securing and digesting the food is so great that its ultimate nutritive value is correspondingly diminished."

Ether Extract.—This contains, as well as fat, waxes, chlorophyll and some of the organic acids. It is considered to be very impure in the case of the coarse fodders, containing sometimes as much as one-half of non fatty substances. The method used for this estimation is again the American Official method. Ward (1917, pp. 326—327) recommends that, in order to overcome errors arising from the porosity of corks used in the Soxhlet apparatus and the solubility of certain constituents of the cork in the extraction solvent, the cork should be heated for two hours on a boiling water bath in a solution of gelatin (previously soaked in cold water for five or six hours and then melted) in a quarter of a volume of glycerol and two volumes of water. They may be then removed, dried and employed in a Soxhlet apparatus for an hour. Thus treated they may be used to advantage with any solvent in the vapour of which water and glycerol are not readily soluble.

Pentosans.—In using the official American method for the estimation of the pentosans in grasses, I am fortunate in having a small supply of phloroglucin, which has been practically unobtainable. Should it not be forthcoming for future determinations some other method must be substituted. That suggested by Jolles (1906) involves the use of orcinol which has also been difficult to procure. Details of a third method which is a modification of the phenylhydrazine method have been given by Menaul and Dowell (1919). Brunnich (1907) recommends Tollens' (1902) method for the determination of pentosans, but phloroglucin has, up to the present, been found so satisfactory a reagent that other methods will hardly be adopted as long as it is available.

Moisture.—This has been determined by heating the material to constant weight in the water oven (Brunnich and Smith 1907).

Ash.—In the determination of the ash, the American official method has again been followed.

Carbohydrates, so far, have been determined, as is usually the case, by difference. This method, however, is far from satisfactory, and the writer hopes to be able to estimate them in more detail at a later stage in the work.

v. *Experimental.*

As before mentioned, the experiments described in this paper have been carried out on the air-dried material. Agricultural chemists generally have found that, after allowing for the moisture content, there is no great difference between the chemical constitution of the green and the air-dried material of feeding stuffs (Brunnich and Smith, 1907). Honcamp (1915) carried out numbers of experiments with both, and he considers that, if the material is dried *in vacuo*, there is absolutely no difference in the nutritive value. The analysis of the air-dried material may, perhaps, also be considered the more reliable of the two. The results of the analyses of grasses from various parts of the State are shown in Table I. With regard to the meaning of the terms "crude" protein and "true" protein used in the tables, "crude" protein represents the total nitrogen, as determined by the Kjeldahl Gunning Arnold method before mentioned, multiplied by the factor 6.25. The use of this factor has been subjected to a good deal of criticism in America and elsewhere, but American chemists have not, so far, succeeded in finding any other factor which would give more accurate results in the case of grasses. G. L. Bidwell (1916) writing on this subject, states that, although in the case of wheat and other substances containing a few well known proteins a factor giving better results may be easy to obtain, it is a different matter in the case of substances in which the protein content is of a complex character. He says "consider the labour involved in determining the factor to apply to any one substance. It would be necessary to determine the amount of each protein in that substance then to prepare it in a pure condition so that the percentage of nitrogen might be determined therein. This is a problem for the specialist who has available almost unlimited time and money" (p. 29). He recommends the retention of the factor 6.25 in such cases, and it has therefore been made use of in the preliminary stages of this work.

The term "true" protein is used to designate the precipitate obtained by Stutzer's Reagent. This precipitate is Kjeldahled as in the case of the crude protein, and the result so obtained is multiplied, as before, by the factor 6.25 (Assocn. Offic. Agric. Chemists, 1920). The albuminoid ratio mentioned in the tables is "the ratio of non-nitrogenous to nitrogenous nutrients in any food" (Murray, 1914, p. 325). In order to determine this ratio, the non-nitrogenous nutrients must all be expressed in the terms of one of them—carbohydrates. The amount of ether extract must, therefore, be multiplied by a factor which represents the value of fat as compared with carbohydrates. The factor commonly used is 2.3 (Murray, 1914).

vi. *Discussion of Tables.*

Effect of Soil and Climate on the Chemical Constitution of Grasses.

A good deal of work in this connection has been carried out in the United States (Le Clerc and Yoder, 1914), notably in Wyoming (Knight, etc., 1908, 1911), where it was found that the percentage of nitrogen appeared to increase with the increase in altitude, while the percentage of crude fibre, under the

TABLE I. *Analyses of Various Grasses, Mostly at First Stage of Growth.*

Name of Grass and Date forwarded.	Locality and Nature of Soil.	Stage of Growth.	Total Moisture. (%)	Percentages Air Dried Material.								
				Moisture.	Ash	Crude Protein.	True Protein.	Crude Fibre.	Ether Extract.	Pentosan.	Carbo-hydrates other than Pentosan.	Albuminoid Ratio.
Danthonia semi-annularis Labill. 15 Aug., 1920. (dried in laboratory).	Botanic Gardens. Sandy loam.	1st	82.0	8.7	10.1	14.25	8.175	22.65	3.12	20.68	20.50	1 : 3.393
Schedonorus Hookerianus Benth. (Syn. *Festuca Hookeriana* F.v.M.) 17 Aug., 1920. (dried in laboratory).	Hawkesbury Ag. Coll. Light grey silt.	1st	81.0	10.10	10.8	15.56	8.065	23.50	4.82	19.19	16.05	1 : 2.977
S. Hookerianus Benth. 17 Aug., 1920. (dried in laboratory).	Botanic Gardens. Sandy loam.	1st	84.58	9.08	8.27	15.75	8.89	22.90	4.448	17.73	21.822	1 : 3.161
S. Hookerianus Benth. 17 Aug., 1920. (dried at Gardens).	Botanic Gardens. Sandy loam.	1st	84.59	8.99	8.276	15.75	8.41	22.89	4.42	17.692	21.982	1 : 3.164
D. semi-annularis Labill. 3 Nov., 1920. (dried at Farm).	Cowra State Expl. Farm. Sandy loam, Granite origin.	1st	80.89	8.89	7.13	16.48	10.85	23.30	3.53	17.03	23.64	1 : 2.961
S. Hookerianus Benth. 27 Sept., 1920. (dried in laboratory).	Glen Innes Expl. Farm. Gravelly and comparatively poor.	1st	79.0	9.5	8.30	15·75	6.50	22.43	3.01	17.37	23.64	1 : 3.044
S. Hookerianus Benth. 3 Oct., 1920. (dried at Farm).	Ditto.	1st	85.63	9.23	8.35	16.18	11.23	22.41	3.81	16.89	23.13	1 : 3.015
Panicum prolutum F.v.M. 19 Oct., 1920. (dried at College).	Hawkesbury Ag. Coll. Light grey silt.	1st	75.98	9.98	6.28	15.57	8.68	23.40	4.43	17.93	22.46	1 : 3.249
P. prolutum F.v.M.* 8 Nov., 1920. (dried in laboratory).	Ditto.	2nd	68.21	8.31	4.87	7.51	5.88	27.55	3.51	22.12	26.13	1 : 7.500
D. semi-annularis Labill. 6 Dec., 1920. (dried in laboratory).	Glen Innes Expl. Farm. Gravelly and comparatively poor.	3rd	69.42	7.52	5.32	5.68	3.55	33.25	3.01	26.78	18,44	1 : 9.180

* This grass has been cultivated by the Department of Agriculture for the past twelve years under the common name of Coolah Grass.

same conditions, showed a decrease. Also that, in comparing samples collected during the summer with those collected during the winter months, a falling off in the percentage of protein was noticed during the winter months, while the percentage of crude fibre was greater in the winter samples. The percentage of ether extract was found to drop materially in the winter samples.

As may be seen from Table i., *Schedonorus Hookerianus* Benth. (syn. *Festuca Hookeriana* F.v.M.), has been analysed at the first stage before mentioned from Glen Innes, Hawkesbury Agricultural College and the Botanic Gardens. There is apparently very little difference between the protein content of the samples from Hawkesbury and the Botanic Gardens, both of which places are practically at sea level, but that from Glen Innes, at an elevation approximating 4000 feet, shows a distinctly larger amount of protein. As to how much of this variation may be due to difference in altitude, and how much to soil, etc., I am not prepared at this early stage of the work to form any conclusion. At Hawkesbury Agricultural College the soil in which the grasses are grown is a relatively poor one. Dr. Jensen (1912) describes it as a light grey silt, strongly acid in character. The experimentalist at Glen Innes states that the soil of the grass plots there is generally regarded as poor—though suitable for cereal growing—and decidedly clayey, light in colour and inclined to be gravelly. It is apparently derived from a basalt, probably bauxitic in character.

Again in comparing the analyses of *Danthonia semi-annularis* Labill. in the first stage from the State Experimental Farm at Cowra, which is at an altitude of about 1000 feet, with a sample from the Botanic Gardens in the same stage, the protein content of the Cowra Sample was found to be higher than that from the Botanic Gardens. Jensen (1914), writing on "The Soils of Cowra" states that the dominant soil there is a warm red loam, overlying a stony and fairly heavy clay subsoil, which merges into rotten granite. He also says "we get granite dominating on the Experiment Farms of Cowra and Bathurst." The Botanic Gardens soil is described as a sandy loam, and is decidedly poor, according to Mr. Ward, Superintendent at the Gardens. It will be interesting to see whether further work on samples from localities differing in soil, altitude, etc., will tend to confirm these particulars. This is, I think, an important phase of the question.

So far there are no noticeable variations between summer and winter samples, but these may become apparent when a greater number of grasses have been examined. In connection with the results given in Table i., a somewhat remarkable variation is seen in two samples of *Schedonorus Hookerianus*, obtained from Glen Innes State Experiment Farm. One of these samples was sent on to me as soon as cut, and, owing to some delay in transit, arrived in a decidedly wilted condition. It was air-dried in the laboratory. The other sample was dried at the Farm under natural conditions. The first sample was found to contain 0.43% less of crude protein than the second. When, however, the true protein nitrogen, or albuminoid nitrogen, as it is called in America, was estimated in each, the wilted sample was found to contain 5.73% less of the so-called true protein than the sample which was dried on the Farm. The percentage of amino acid, amides, etc., was, however, correspondingly larger, as these substances represent the difference between the so-called crude and true protein. The actual figures are:—

	Crude Protein.		True Protein (albuminoid N).
Schedonorus Hookerianus, first stage (wilted sample)	15.75%	..	6.50%
Schedonorus Hookerianus, first stage (good sample)	16.18%	..	11.23%

TABLE II.

Showing variation in Protein Content at different Stages of Growth.

Name and Date.	Locality and Nature of Soil.	Stage of Growth.	% Crude Protein.	% True Protein.	Remarks.
Schedonorus Hookerianus 27 Sept., 1920. (dried in laboratory).	Glen Innes Experimental Farm (4000 feet above sea level). Gravelly and comparatively poor.	1st	15.75	6.50	
S. Hookerianus. 3 Oct., 1920. (dried at Farm).	Ditto.	1st	16.18	11.23	
S. Hookerianus. 9 Feb., 1921. (dried at Farm).	Ditto.	2nd	10.706	7.895	Flowers not long fertilised.
Panicum prolutum. 19 Oct., 1920. (dried at College).	Hawkesbury Agric. College. Light grey silt.	1st	15.57	8.63	
P. prolutum. 8 Nov., 1920. (dried at College).	Ditto.	2nd	7.51	5.88	Flowers not long fertilised.
P. prolutum. 12 Dec., 1920. (dried at College).	Ditto.	3rd	6.74	5.10	Seed set.
Eragrostis leptostachya. 12 Jan., 1921. (dried at College).	Ditto.	2nd	11.98	9.20	Seed just beginning to set.
E. leptostachya. 12 Jan., 1921. (dried at College).	Ditto.	3rd	8.167	7.20	Seed set.
S. Hookerianus. 15 Aug., 1920. (dried in laboratory).	Botanic Gardens. Sandy loam.	1st	15.75	8.39	
S. Hookerianus. 15 Aug., 1920. (dried at Gardens).	Ditto.	1st	15.75	8.41	
S. Hookerianus. 24 Jan., 1921. (dried at Gardens).	Ditto.	2nd	10.325	8.025	Seed beginning to set.
Danthonia semi-annularis. 15 Aug., 1920. (dried in laboratory).	Ditto.	1st	14.25	8.175	
S. Hookerianus. 17 Aug., 1920. (dried in laboratory).	Hawkesbury Agric. College. Light grey silt.	1st	15.56	8.065	
D. semi-annularis. 3 Nov., 1920. (dried at Farm).	Cowra Experimental Farm (978 feet above sea level). Sandy loam, granite origin.	1st	16.48	10.85	
D. semi-annularis. 6 Dec., 1920. (dried in laboratory).	Glen Innes Experimental Farm. (4000 feet above sea level). Gravelly and comparatively poor.	3rd	5.08	3.557	Seed set.
Danthonia pilosa (?) R.Br.* 29 Dec., 1920. (dried on Farm).	Yanco Experimental Farm. Chocolate loam, with hard clayey subsoil.	2nd	8.05	6.50	Seed beginning to set.
Panicum prolutum. 24 Jan., 1921. (dried at Gardens).	Botanic Gardens. Sandy loam.	3rd	5.952	4.280	Seed set.
Panicum decompositum R.Br. 24 Jan., 1921. (dried at Gardens).	Ditto.	3rd	5.325	4.20	Seed set.
Pollinia fulva Benth. 24 Jan., 1921. (dried in laboratory).	Ditto.	2nd	9.520	7.152	Seed beginning to set.

* The genus *Danthonia* is now under revision by Messrs. Cheel and Breakwell, of the Botanic Gardens staff, and it is quite possible that the *D. pilosa* group will be split up and renamed.

as will be seen from Table i. Analyses carried out on other grasses at this stage show that the non-protein nitrogen is usually about 40% of the total nitrogen, so that, in the case of the wilted sample, there has been apparently, a breaking down of the proteins into their cleavage products. I hope to carry out further experiments under similar conditions, in order to verify the result which has been shown above. The non-proteins are found to be especially abundant in immature plants, where the protein formation has not yet been completed, and in fermented foods such as silage, where the proteins have been partially decomposed (Sleeter Bull, 1916). Some such decomposition has apparently taken place in the wilted sample of grass from Glen Innes. Sleeter Bull (1916) also considers that there are considerable differences in the nutritive value of the amino acids, some being essential to life, while others are essential to growth only. "Therefore," he says, "different proteins may differ considerably in nutritive value," e.g., zein, the principal protein of maize, has no lysine or tryptophane (Osborne and Mendel, 1916). So far no great variations have been observed in the percentages of ether extract. The crude fibre content appears to be rather low compared with American grasses (Griffiths, etc., 1915), the pentosan also showing a slightly lower percentage. If these results are borne out by subsequent investigation, our native grasses should compare favourably with those of the United States, as the percentage of protein appears to be about the same in each. It will be noticed that the percentage of ash shows a decided drop at the second stage of growth. There is, of course, nothing unusual about this. Preston (1887) and Knight, Hepner and Nelson (1911), stress the importance of giving particulars as to locality, soil, etc., in these analyses. They have therefore been included in Table i.

On examination of samples at the different stages as given in Table ii., the highest crude protein content, so far, has been found to occur in samples collected at the first stage and to diminish gradually as the grass grows older. As before mentioned, however, crude protein at this stage is considered to consist largely of amino acids, amides, etc. (Sleeter Bull, 1916), which although highly important constituents (Osborne and Mendel, 1916; Nollau, 1915), have hardly such a high nutritive value as the true proteins.

In grasses examined at the second stage the protein content apparently lessens considerably (Söderbaum, 1918). I have examined the flowers of some grasses at this stage, and results are given in Table iii. I find that, at this stage, apparently a considerable proportion of the protein is found in the flower itself, and that considerably less occurs in the leaves and stems than was the case at an earlier stage. At the third stage still less appears to occur in the leaves and more in the seed (Petrie, 1911; Schulze and Schutz, 1909).

In connection with this work, my best thanks are due, first of all, to Professor Watt, Dean of the Faculty of Agriculture in the University of Sydney, in whose Department and under whose supervision the research is being carried out, and to Mr. G. Wright, Lecturer in Agricultural Chemistry in the University, for many practical suggestions; to Mr. J. H. Maiden, for his kindness in allowing me the use of the National Herbarium and of the library at the Botanic Gardens, and for his readiness to afford me any assistance in his power; to the members of his staff, particularly Mr. E. Breakwell, Agrostologist, and his Assistant, Mr. Whittet, who have gone to much trouble in procuring material for me and helping me in other ways, and to Mr. W. M. Carne, Hawkesbury Agricultural College, and the managers of the various Experiment Farms for forwarding material, etc. I am also indebted to Dr. J. M. Petrie for much

TABLE III.

Showing Amount of Protein in Flowers.

Name.	Locality and Date.	Percentage of Crude Protein in Flowers.	Remarks.
Panicum prolutum (dried in laboratory).	Hawkesbury Agric. College. 10 Nov., 1921.	13.823	Not long fertilised.
Schedonorus Hookerianus. (dried at Farm).	Glen Innes. 9 Feb., 1921.	13.925	Not long fertilised.
Eragrostis leptostachya. (dried at College).	Hawkesbury Agric. College. 12 Jan., 1921.	14.735	Seed is just beginning to set.
Danthonia semi-annularis. (dried at Farm).	Glen Innes. 9 Feb., 1921.	12.302	Unfertilised.
Schedonorus Hookerianus. (dried at Gardens).	Botanic Gardens. 24 Jan., 1921.	14.023	Seed is just beginning to set.

The grasses mentioned in this table are the only ones which have been procurable so far, in the flowering stage.

valuable assistance. Lastly, I must pay a tribute to the very kindly interest which has been shown by Sir Edgeworth David in the progress and welfare of my work.

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STUDIES IN LIFE-HISTORIES OF AUSTRALIAN DIPTERA BRACHYCERA.

PART i. STRATIOMYIIDAE.

No. 2. Further experiments in the rearing of *Metoponia rubriceps*.

BY VERA IRWIN-SMITH, B.SC., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

(Eight Text-figures.)

Attempts to rear the larval *Metoponia rubriceps* from the egg, which were made last year and described in the first paper of this series, were continued throughout the Spring and Summer, and have at last met with a considerable measure of success. It has been found possible to breed from flies reared from the larva in captivity, and the cycle, from larva to the larva of the next generation, has been obtained. Unfortunately, the bred larvae all perished at an early stage, so that the cycle is not yet quite complete, and the length of time occupied in the larval state has still to be determined.

The larvae used in the experiments were those collected in May and August of 1920. Early in the following Spring, many began to show signs of the immobility which marks the onset of pupation, and, as this occurred, the pupating larvae were put into separate vessels. Common half-pint glass preserving jars were found most suitable for the purpose, filled to a depth of an inch or two with the sandy soil in which the larvae normally live, and planted with a little couch grass, having stems long enough to afford a resting place for the flies as they emerged. The soil was kept slightly damp, and the jars, loosely covered with metal screw tops, were kept on a window ledge where they were exposed to direct sunlight for several hours after sunrise. Each jar contained several pupae, judged by their sizes to be of the two sexes.

Under these conditions, a good proportion of the pupae completed their development, and imagines appeared over a much longer period than had been observed in the field. The earliest, a male, emerged on 11th October, while others were obtained as late as December. One pupa noticed to be immobile on 12th December, was dissected on 19th December, and found to be still in a very early stage of pupation.

During this Spring, very few of the adult flies were caught in the field. A long period of drought had evidently proved unfavourable for their development. The lawn at the Australian Museum, from which the larvae had been obtained, had become very dry, and the earth had caked hard, when it was searched for larvae and pupae on 4th November. Though a good number

of living larvae were found, full pupal cases were very scarce, and the majority of those found contained dead and decayed pupae.

Under these circumstances it was impossible to carry out breeding experiments with flies obtained in the adult stage, and it became necessary to rely on those bred out in the laboratory. Unfortunately, in most cases they emerged singly, and at such long intervals that flies of both sexes were rarely alive at the same time. However, on the morning of 11th November, two flies, a male and a female, emerged in the one jar, within a short time of one another. They immediately crawled up the grass stems, and remained there, quite motionless, for the first two days. On the third morning, 13th November, the intense light of a hot day seemed to have roused them to activity, for they were found during the morning, engaged in a "courting" dance in the sunshine, following one another in rapid flight up and down the grass stems, and sides of the vessel. Copulation was not observed, but at seven o'clock on the following morning, 14th November, a small white cluster of eggs was found deposited in a single irregular clump, against the side of the jar, on a level with the surface of the soil. Next day the male died, and the female lived only one day longer.

In view of the previous failures with eggs which had been handled, it was judged safer to leave these eggs entirely undisturbed, and trust to the very imperfect observation afforded through the glass of the jar, to determine whether any changes occurred in them. The lid was kept on the jar, and a slight amount of moisture retained in the soil.

At the end of the first week, the eggs appeared to darken in colour, and by 27th November, the fourteenth day after deposition, they had become amber coloured. No further observation was made until 30th November, when the egg clump was not visible at all. The soil, therefore, was carefully turned out, in small quantities, on to glass Petri dishes, and examined under the microscope. The search was rewarded by the finding of newly hatched, living larvae, no bigger than the particles of soil among which they were crawling, and of eggs which contained unhatched, but well-developed larvae. The latter were picked out with a camels-hair brush, and kept, for further observation, on a small quantity of damp soil in a small crystal dish. However, either they were already dead, or the change of environment proved fatal, for no further development took place in them, and after a few days they were all decayed and covered with fungus.

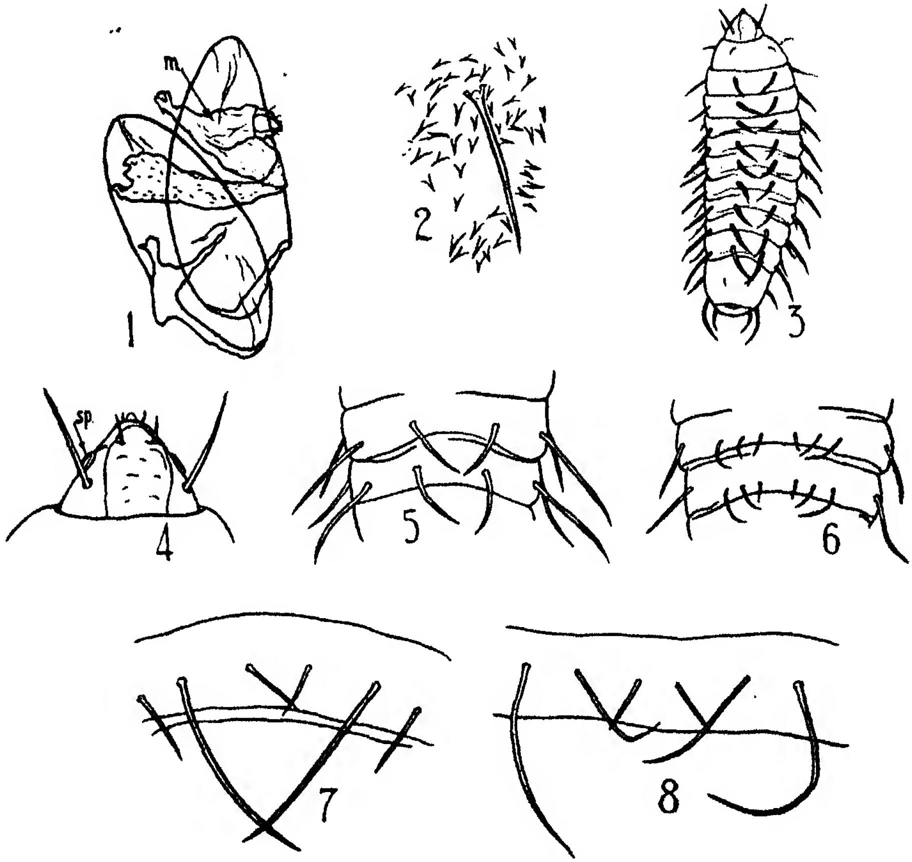
The quantity of soil in which it was possible to pick out the almost microscopic larvae, was obviously insufficient for the growth of grass for their nourishment. Accordingly, it was decided that the best chance of carrying out the chief aim of the experiment, the rearing of the larvae to maturity, was to place them in a large jar full of soil, containing a good growth of grass, and refrain from any further attempt to handle them until they had had time to increase greatly in size.

Unfortunately, this object was not attained. The jar containing the larvae was left undisturbed until the end of February, a period of three months; but when the soil was turned out, no trace of the larvae was found, under the most searching microscopical examination. Difficulty had been experienced in keeping the grass alive, and a constant degree of moisture in the soil, during the hottest summer weather, especially during a period when, through absence from Sydney, I was unable to attend to it myself. The larvae had evidently died under unfavourable conditions, or been lost during the removal of dead grass. 'Previous experiments in the rearing of larvae collected in the field had

shown that the younger the larvae, the more difficult they are to preserve alive. Adverse conditions which had no ill-effect on larvae over 6 mm. in length, invariably proved fatal to the smaller ones, and no larva under 5 mm. length, when collected, has, so far, been successfully brought through to the pupal stage.

Description of the newly-hatched larva.

Newly-hatched larvae measure from 0.8 to 0.96 mm. in length, and 0.27 mm. in lateral width. The chief structural differences from older larvae are found in



Metoponia rubriceps Macq.

Fig. 1. Empty egg cases, and moult skin (M). (x 48). Fig. 2. Portion of moult skin shown in Fig. 1. (x 475). Fig. 3. Newly hatched larva. (x 48). Fig. 4. Head of newly hatched larva. (x 175). Figs. 5-6. Dorsal view (5) and ventral view (6) of segments of newly hatched larva. (x 100). Figs. 7-8. Dorsal view (7) and ventral view (8) of segment of a larva 2 mm. long. (x 100).

the formation of the head, and in the arrangement of the bristles on the body. The eyes are quite rudimentary, and there is an entire absence of the lateral lobes which form such a prominent feature in larvae of larger growth (Fig. 4).

On the other hand, the head spiracles (?) are relatively much larger and more prominent (*sp.*). A small area of dark cuticle above each of them, indicates the position in which the lateral "boss" grows out later, evidently as a protective structure above the spiracle.

On the dorsal surface of each of the body segments there are instead of six, only two stout bristles. Tiny rudiments of the other bristles can be seen on some segments. The smallest larvae collected in the field, 2 mm. long, show these on all segments (Fig. 7), and the first bristles developed are found to be the middle one on each side. On the ventral surface, six bristles are present in the newly-hatched larva, but they are not equally developed and are very small and inconspicuous (Fig. 6). The outermost bristle on each side is the longest, and this is the case, still, at the 2 mm. stage (Fig. 8). It is, therefore, only with later growth that all the bristles of each surface become uniform in size. On the lateral ridges only the two larger bristles are present at first. These, at hatching, are about 0.12 mm. long, and give the larva a conspicuously hairy appearance.

The larva escapes from the egg through an irregular rupture extending up from the broad pole (Fig. 1). The first moult evidently occurs immediately after hatching, since many cast skins were found tangled up with the empty egg-cases (Fig. 1). These skins differ considerably from those of later moults. They are very soft, and delicate, do not retain the shape of the larva, and are not coated with calcareous hexagonal plates. In place of the plates are numerous delicate, finely-pointed processes (Fig. 2) scattered irregularly between the bristles. In larvae still contained in the egg, the armoured coat can be seen, already developed, beneath this skin. The structure of the head can be made out more easily in the moult skin than in the unhatched larva. Both show an earlier stage of development than the hatched larva, which is especially interesting in the case of the mouth-parts. These will be considered later, in conjunction with a detailed study of the fully-developed larval mouth-parts. The structures which have the appearance of spiracles are very conspicuous, and each is seen to connect, internally, with a small tube, which can be traced for a short distance into the head.

THE OCCURRENCE OF CALCIUM OXALATE IN THE GIDGEE WATTLE (*ACACIA CAMBAGEI* BAKER).

By Thos. Steel.

References in literature to the occurrence of calcium oxalate in plants are numerous, but records of the amounts present are comparatively scarce. A few of the more important of the latter may be noted. In 1877, W. M. Hamlet and C. R. Plowright (Chem. News, xxxvi., 1877, p. 93; Journ. Chem. Soc., ii., 1877, p. 796) drew attention to the presence of oxalic acid in a large number of fungi, the acid apparently existing in the free state, as hydric potassium oxalate and as calcium oxalate. *Fistularia hepatica* (86% water) contained 0.08% of total oxalic acid, equal to 0.57% in the dry plant, and equivalent to 0.73% calcium oxalate ($C_2O_4Ca+H_2O$).

The presence of the same acid in small amounts in potatoes and malt is recorded by Siewert (Journ. Chem. Soc., 1883, abs. p. 232). Berthelot and Andre (Journ. Chem. Soc., 1886, abs. p. 734) state that they found 13.9% oxalic acid, which is equivalent to 17.8% calcium oxalate, in the roots (dry) of *Rumex acetosa* (common sorrel). Of the 13.9% oxalic acid, 5.9 was in the soluble state and the remainder insoluble.

H. G. Smith (Journ. Roy. Soc. N.S. Wales, xxxix., 1905, p. 23) in a comprehensive paper describes the occurrence of considerable amounts of calcium oxalate in the bark of numerous species of *Eucalyptus*, the percentages present varying from 0.08 to 16.66 of $C_2O_4Ca+H_2O$ in the dry bark.

The occurrence of the same substance in cinnamon and cassia barks was recorded by J. Hendrick (Analyst, xxxii., 1907, p. 14) who found from mere traces up to 3.5% in commercial samples and 6.62% in one of Ceylon wild cinnamon.

J. Otto (Journ. Soc. Chem. Ind., xxxi., 1912, p. 411) found from 0.4 to 0.9% calcium oxalate in the young needles of pine trees, while old shoots contained 2.3% and young larch leaves 0.1%, all in the dry material.

R. T. Baker (Journ. Roy. Soc. N.S. Wales, li., 1917, p. 435), as the result of microscopic examination, detected crystals of the same compound in the cells of a large number of Australian timbers.

Further references to various phases of this subject will be found in the collective indices of the Chemical Society and of the Society of Chemical Industry.

F. B. Guthrie (Agric. Gazette N.S. Wales, viii., 1897, p. 868) recorded an analysis of the ash of the Gidgee or Stinking Wattle (*A. Cambagei*), showing 90.7% of lime (CaO) and 0.40% potash (K_2O).

Another sample of Gidgee ash offered commercially for manurial purposes and examined by myself in 1898, contained a similar large proportion of lime and small one of potash.

Being struck by the probability of this proportion of lime being due to the presence of unusual amounts of calcium oxalate in the plant, I obtained from Mr. Maiden samples of the timber and bark of *A. Cambagei* and submitted them to detailed examination, with the results following:—

I have calculated the oxalate as $C_2O_4Ca+H_2O$, following H. G. Smith, cited above, who found this to be the constitution of the oxalate separated mechanically from Eucalyptus bark. The method of determination used was similar to that described by Smith, with the exception that I ignited the oxalate precipitate completely and weighed as CaO.

Timber and bark of *Acacia Cambagei*.

(Calculated to dryness.)

	Outer bark.	Inner bark.	Outer wood. (white).	Inner wood. (dark).	Average wood.
Ash soluble in acid	8.48	8.43	3.28	2.53	2.86
Sand	1.15	.44	0.00	0.00	0.00
Potash (K_2O)	0.06	0.06	0.08	0.05	0.06
Lime as oxalate	8.20	8.16	3.08	2.46	2.70
Total lime (CaO)	7.22	7.22	2.23	1.46	1.83
Calcium oxalate ($C_2O_4Ca+H_2O$)	18.82	18.82	5.81	3.81	4.77
Water in air-dried sample	8.80	9.30	9.00	9.20	9.05

These proportions of calcium oxalate in the bark of *A. Cambagei* are the highest I have seen recorded for any plant.

G. Kraus (Journ. Chem. Soc., 1892, abs. p. 1370) concludes from the results of experiments on the bark of various trees which contain calcium oxalate in quantity, that this substance constitutes a reserve deposit and is not an excretion, and that it is redissolved in spring and summer according to the needs of the plant. Branches of *Ribes sanguineum* and other trees varied in their calcium oxalate content with the seasons, the amount present being highest in winter and lowest in spring and summer. The author states that calcium oxalate is certainly liable to solution by long-continued action of an acid circulating liquid like cell sap.

The abstract does not give any details regarding the structure or appearance of the bark examined. I feel more than doubtful about this conclusion. A fall in the oxalate content of the bark during the growing period is more likely to be due to the addition of new bark free from oxalate, than to the solution of the oxalate already deposited. Oxalic acid is usually considered a waste product, harmful to the plant, fixed with lime in order to render it insoluble and harmless, and we know that it is shed in large amount in leaves and bark.

We have seen above that the dead, dry, outer bark of *A. Cambagei* contains the same proportion of oxalate as the inner bark, and even of the latter only a comparatively thin layer may be in metabolic function, in which condition alone it could receive or part with its load of oxalate.

Smith (Journ. Roy. Soc. N.S. Wales, xxix., 1895, p. 325; xxxvii., 1903, p. 107) concluded in the case of *Orites excelsa*, which he found to contain large amounts of aluminium succinate, that the succinic acid was a waste, poisonous

metabolic product, fixed by the plant with the only available base forming an insoluble succinate, in order to get rid of it.

To determine in how far the barks of other species of *Acacia* resembled *A. Cambagei* in calcium oxalate content, the barks of a number were examined. Through the courtesy of Mr. Maiden I was provided with these from the collections in the Herbarium Museum at the Botanic Gardens, Sydney. The analysis of this series was made for me by my colleague, Mr. E. F. Vaughan, to whom my thanks are due. All the samples were of mature bark which had become thoroughly air dried.

Percentages in Acacia barks (calculated to dryness).

	1	2	3	4	5	6
Total ash	2.01	1.56	3.05	6.80	6.14	6.05
Total lime (CaO)	1.64	0.91	2.63	2.54	4.04	5.60
Lime as oxalate	0.52	0.60	1.67	2.05	2.58	3.42
Calcium oxalate ($C_2O_4Ca+H_2O$)	1.36	1.56	4.36	5.35	6.74	8.92
Water in air-dried sample	11.43	11.75	13.20	9.58	12.88	10.83

In the total ash the lime was ignited to CaO.

1. *A. Cheelii* Blakely; 2. *A. adunca* A. Cunn.; 3. *A. auriculiformis* A. Cunn.; 4. *A. decora* Reichb.; 5. *A. salicina* Lindl.; 6. *A. aneura* F.v.M.

As in the case of the Eucalyptus barks examined by H. G. Smith there is considerable variation in the amount of oxalate present, but in none of the samples is the high percentage in *A. Cambagei* approached. A variable amount of lime is seen to be in combination other than as oxalate. The bark of *A. decora* contained a comparatively large amount of ash insoluble in acid and was high in iron and alumina, which might be due to admixture with earthy matter, but there was nothing in the appearance of the bark to indicate this.

In a lengthy article on the chemistry of forest trees, by R. Warington in Watt's Dict. Chemistry (viii., Pt. 1, 1879, p. 800), a considerable mass of information on the ash constituents of the bark, timber and leaves of trees is collected. A critical examination of this shows clearly that in most of these lime is the predominating constituent, and that there is never sufficient inorganic acid present to fully satisfy the lime and other bases. Throughout the article no specific mention is made of oxalic acid, though it is stated (p. 809) that the carbon dioxide in the ash represents the organic acids with which the bases were originally united, and that the proportion of bases combined in this way is apparently greater in old than in young wood [and bark.] In the light of present knowledge a study of the data given strongly indicates the presence, in many of these timbers and barks, of very considerable proportions of calcium oxalate.

NOTE ON A GLACIALLY-STRIATED PAVEMENT IN THE KUTTUNG SERIES OF THE MAITLAND DISTRICT.

By G. D. Osborne, B.Sc., and W. R. Browne, B.Sc.

(Plate xxii., and one Text-figure.).

Our knowledge of glaciation of definitely Carboniferous age in New South Wales dates back to the visit of the British Association for the Advancement of Science to this State in 1914, when, during one of the geological excursions, Professor David made the discovery of definite tillite at Seaham, in the Maitland District, an identification which was concurred in by Professors Penck and Coleman. Following on this discovery, field work, chiefly by Mr. C. A. Sussmilch and also by Professor David and others, resulted in the identification of further evidences of Carboniferous glaciation in the shape of tillites, fluvio-glacial conglomerates containing faceted and striated pebbles and seasonally-banded glacial shales—varve rock—on various horizons, sometimes exhibiting contemporaneous contortion. The results of these researches are embodied in an important paper by Mr. Sussmilch and Professor David (Journ. Proc. Roy. Soc. N.S. Wales, liii., 1919, pp. 246—338).

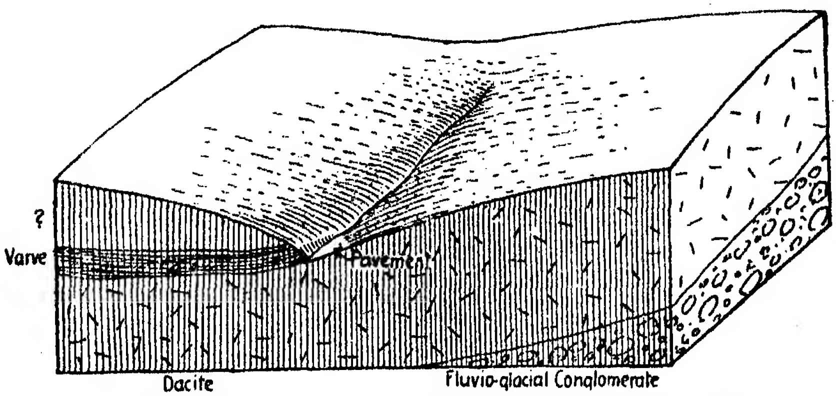
Glacial conglomerates and varves have now been recognised in many localities in the Southern Carboniferous areas as well as further north at Currabubula, near Tamworth (These Proceedings, xlv., 1920, p. 286), but apart from the occurrence of the Seaham tillite and the indication by the existence of varves of the proximity of land ice to the site of their deposition, no definite evidence of the presence of such land ice at any particular spot in the Hunter Valley had been obtained until the recent discovery of the striated pavement which forms the subject of this note.

One of the authors (W.R.B.) is at present engaged in the investigation of the Carboniferous rocks occurring principally in the parishes of Wolfingham and Gosforth, near West Maitland, and it was during a short visit by both authors to these districts in February last, that the pavement was found, the actual discovery being due to Osborne.

The pavement is situated in portion 10, Parish of Wolfingham, near the eastern boundary of the parish. A surveyed road, leading from the neighbourhood of Gosforth to Paterson Township, after ascending a spur of the scarp bounding the plateau, forms the boundaries between portions 10 and 13. At the

north-east corner of portion 13 this road is crossed by a creek, a tributary of Webber's Creek, and in this creek, about 100 yards east of the road, a very good section of varve rock is seen, the varves showing a dip of 18° in direction N. 35° W. These rocks are underlain by a dark, fairly massive mudstone possessing a sub-conchoidal fracture and containing indeterminate plant remains, and the outcrop is continued up a small tributary gully or creek coming in from the south and running approximately parallel to the road and about 200 yards to the east of it. Proceeding up this creek about 250 yards one comes upon the pavement, of which there are two exposures in the bed of the creek, separated from one another by a distance of about 2 chains.

As is frequently the case in the Carboniferous areas, the creek has eroded the junction between the dipping varves and the underlying harder rocks, and it is in this way that the pavement, which has quite probably been obscured by alluvium until comparatively recently, has been exposed. (*See* Text-figure).



Block diagram, illustrating the physiographical and stratigraphical position of the striated pavement.

The total area of the pavement observable is small, probably not above six square feet at each exposure, but if the overlying varve rock and soil were removed a much greater glaciated surface would doubtless be brought to light. The rock has been smoothed, grooved or fluted, and striated, and small indentations have been produced by the "scooping-out" action of the ice. In addition, a little ledge of the rock composing the pavement, which evidently rose about a couple of inches above the general level, has also been glaciated, and now shows sub-horizontal grooving along its vertical face.

There can be no reasonable doubt that this striated pavement represents the action of ice. The possibilities of differential erosion along flow lines in the igneous rock of the pavement, and of slickensiding have been considered and rejected, and, besides, the markings are similar to those observed at Bacchus Marsh (Vic.) Inman Valley and Hallet's Cove (S.A.) and elsewhere, but the grooves are less deeply incised owing doubtless to the ice-sheet, which produced them being thinner than that which glaciated the above three areas so heavily.

The direction of the striae on the glaciated surface is N.13°W—S.13°E. The sense of the movement of the ice has been determined by the examination of a depression, scooped out on the original floor and subsequently filled with varve material, the profile of which indicates that the ice was moving in a northerly

direction. This indication of the ice having had an origin to the southward is of great interest. For, from palaeogeographic considerations and from the evidence of the various conglomerate horizons in the Kuttung Series, especially the Wallarobba Conglomerates occurring as a marginal belt to the present New England massif, it seems reasonable to infer that a considerable area of high land existed to the north-east of the present Carboniferous areas (*cf.* Sussmilch and David, 1919, pp. 277—281) right on till the advent of glacial conditions in Upper Kuttung time. On the other hand, the occurrence in the fluvio-glacial conglomerates of Winder's Hill and in the Lochinvar shales of pebbles of gneiss and amphibolite such as have been found by one of the authors on certain parts of the Monaro, seems to suggest that some of the material might have come from the south and south-west. It will be interesting to see whether further discoveries confirm the general south to north direction for the movement of the glaciers.

The floor over which the ice has moved is composed of a biotite dacite, the same which has formed Webber's Creek Falls and which also forms part of the steep eastern escarpment of Lamb's Valley. At the upper exposure it is overlain by well-laminated varve-rock, dipping here N.5°W. at 16½°. In the lower exposure the varve just near the contact contains numerous angular and sub-angular inclusions of various sizes up to about 9 inches in length, many of which are composed of the underlying dacite.

The existence of this striated pavement in direct contact with the varves puts it beyond a doubt, if any existed, that the latter are of glacial origin and entirely comparable with those described by De Geer and Sayles.

As regards the actual horizon of the dacite which bears the glacial markings, it is impossible to say with certainty in what part of the sequence it comes. The section from Winder's Hill to Lochinvar given in the paper by Professor David and Mr. Sussmilch shows fairly accurately part of the sequence in the Gosforth district. On this section two varve horizons are indicated. A third or middle horizon of varves should have been shown at the foot of the first dip-slope south of Winder's Hill, its stratigraphical position being somewhere between the glacial conglomerates and the green tuffs which form the horizon marked (8) on the section mentioned.

Now as one climbs the scarp of what we may for convenience call the Webber's Creek Plateau from the south-east by Bell's track, one crosses first the equivalents of the Winder's Hill conglomerate (the lowest varve is obscured by talus) then, ascending stratigraphically, a rather narrow band of varve, well seen just at the top of the ridge near Mr. Bell's homestead, is encountered, on top of which, or separated from it by only a thin band of conglomerate, is the dacite which further to the east exhibits the glacial striae, this being immediately overlain, as already stated, by a further band of varve-rock. We have not yet examined the sequence any higher than this, so that it is impossible to tell whether the dacite separates the Upper and Middle Varves, being in that case the stratigraphical equivalent of the green tuffs of the Winder's Hill section. But this seems the most reasonable interpretation in the present state of our knowledge. This would put the horizon of the pavement just about that of the varve-rock near the Seaham Hotel, or just a little below that of the Seaham Tillite.

One of the authors (G.D.O.) who has studied the Carboniferous rocks in the Paterson area is of opinion that the Webber's Creek dacite bears a close lithological resemblance to the so-called Paterson "rhyolite." It is only by further field work that any correlation can be established or disproved.

The authors are very much indebted to Professor Sir Edgeworth David for having made a trip to the site of the pavement, the result of his personal observations completely confirming their conclusions as to the glacial origin of the phenomena.

EXPLANATION OF PLATE XXII.

Figs. 1 and 2.—Photographs of the upper exposure of ice-scratched pavement. The little ledge a few inches high to the right of the hammer has also been striated. The direction of the ice-movement has been from right to left of the picture.

Fig. 3.—Photograph of a rubbing of the upper exposure of the pavement. The arrow indicating the direction of the ice-movement has been placed over the position of the depression from which the direction was determined.

COPTOTERMES RAFFRAYI Wasman (Fam. *TERMITIDAE*).

BY GERALD F. HILL, F.E.S.

(Fifteen Text-figures.)

This Termite was described in These Proceedings (Vol. xxv., 1900, p. 244) from specimens of the soldier caste collected by A. M. Lea near the Swan River, Western Australia, but its validity as a distinct species has not been accepted generally by more recent writers. Thus, Desneux (1904) included it, and the two earlier described species *C. lacteus* Froggatt and *C. acinaciformis* Froggatt, in the Australian fauna, while Silvestri (1909) regarded it as synonymous with *C. lacteus* Frogg. Holmgren (1911) merely referred to Silvestri's remarks and omitted it from his list of species; Froggatt (1915), however, followed Desneux in regarding it as specifically distinct. In his list of Australian species the latter writer did not include *C. michaelseni* Silvestri, which is certainly a valid species and recognised as such by Holmgren and Mjöberg (1920).

The examination of numerous series of *Coptotermes* from various Australian localities convinces me that determination of species, based on soldiers and workers only, cannot always be made satisfactorily and that, in some cases, reference to the alate forms is essential. From the published description the differences in the soldier caste of *C. raffrayi* Wasm. and *C. lacteus* Frogg. appear to be so slight that one might, with reason, hesitate to regard them as specific, but with the material now available for study the validity of Wasman's species can, I think, be definitely established. If a comparison of the soldiers here regarded as *C. raffrayi* Wasm. with the types reveals specific differences, the former must be regarded as a new species, differing markedly in the alate forms from those hitherto described. With this possibility in view a description of the soldier is given.

I am indebted to the Authorities of the South Australian Museum for the privilege of examining co-types of *C. lacteus* Frogg. and to Messrs. J. Clark and C. F. Hill, for the specimens described hereunder.

COPTOTERMES RAFFRAYI Wasman. (Figs. 1—15.)

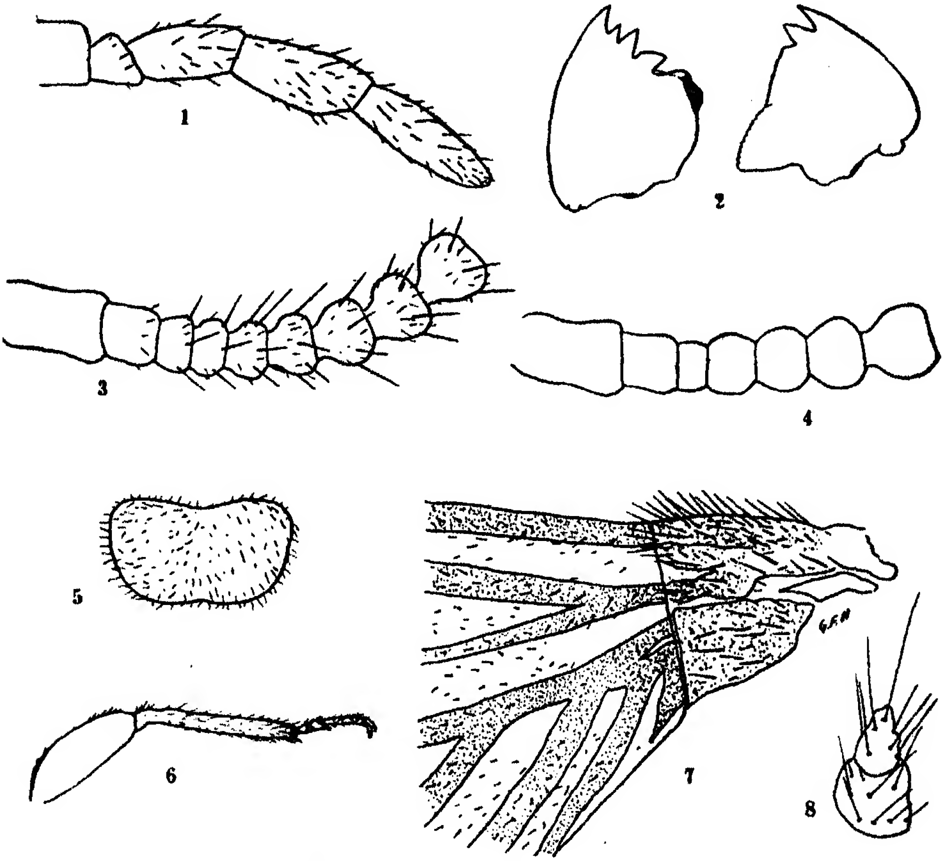
These Proceedings, Vol. xxv., 1900, p. 244.

Imago. (Figs. 1—8.)

Colour: Head, thorax and tergites 2—7 of abdomen dark chestnut, apical half of 8th and the whole of the 9th and 10th tergites ochraceous-orange, head darkest, labrum, post-clypeus, antennae, excepting first two segments, and palpi

yellow-ochre, first and second segments of antennae dark chestnut, sternites of abdomen ochraceous-tawny, apical segments as in tergites, the lateral margins, excepting the apical in the female and penultimate and apical in the male, suffused with dark brown; legs ochraceous-tawny with the apical one-third of femora and the entire tibiae suffused with dark brown; wings smoky, costal margin dark brown.

Head large, rounded, very little narrower than prothorax, slightly depressed on summit, slightly rugose in middle, sparsely clothed with moderately long hairs. Fontanelle minute, circular. Labrum large, convex, narrowed at base, swollen on sides, clothed with scattered long and short reddish hairs. Post-clypeus convex



Coptotermes raffrayi Wasman.—Imago.
Text-figs. 1. **Maxillary palpus**; 2. **Mandibles**; 3 and 4. **Antenna, proximal segments**; 5. **Prothorax**; 6. **Hind leg**; 7. **Hind wing**; 8. **Cercus**.

behind, concave in front, without median suture, three-tenths as long as wide. Ante-clypeus short, membranous, anterior margin slightly produced in the middle. Maxillary palpi (Fig. 1). Mandibles (Fig. 2). Antennae (Figs. 3 and 4) 19- or 20-jointed, arising from a raised tubercle within a small fossa situated, in

front of and close to eye, posterior margin of fossa elevated, segmentation variable but generally as follows:—1st joint short and stout, widest at apex, more than twice as long as wide, twice as long as 2nd; 2nd short, quadrate, as wide as middle of 1st; 3rd and 4th short, subequal, or 3rd shortest and narrowest of all and 4th and 5th subequal. Eyes large, circular (0.352 diam.), facets small (0.016 diam.), surrounded by whitish membrane, lower margin of eye very close to lower margin of head in profile (0.160). Ocelli oval (0.112 × 0.080), separated from eyes by a little less than their short diameter.

Prothorax (Fig. 5) wider than long, slightly concave in front, rounded on the sides, slightly bilobed behind, the entire outer margin slightly bent up, least in front, surface sparsely setose, like head. Meso- and metathorax with a group of setae in the median line about the anterior third, posterior margin of mesothorax as in prothorax, that of metathorax rounded, not at all bilobed. Wing-stumps unequal, those of forewings nearly twice as long as those of hindwings.

Legs (Fig. 6) rather slender, clothed sparsely with reddish hairs, first and third tarsals subequal, much longer than second, fourth long and slender, femora thickened, tibial spurs 3:2:2.

Wings (Fig. 7): Entire surface clothed uniformly and rather densely with short setae; first two veins very distinct, dark brown at base, yellowish towards apex, below the radius suffused with dark brown; radial sector branching within the wing-stump in the forewing, well beyond the suture in the hindwing, dark at base but soon becoming indistinct, running nearer to the radius than to the cubitus, with three or four indistinct inferior branches; median fused with the cubitus (*see* Fig. 7); cubitus with seven or eight branches, the first four or five dark, simple or branched once or twice, the others very indistinct, some branched, all generally joining the hind border in the proximal two-thirds of the wing. Apices of hindwings extending beyond those of forewings.

Abdomen clothed as in prothorax. Cerci (Fig. 8) short and stout. Styli short (0.064), wanting in female.

Measurements:

Length with wings: male 11.75—12.75; female 12.50—13.50.

Length without wings: male 6.25—7.00; female 7.00—7.50.

Head: at and including eyes, wide 1.316—1.410; from posterior margin of clypeus to base 1.128; deep 0.658.

Mandibles: right, long 0.564, wide 0.517; left, long 0.635, wide 0.423.

Prothorax: long 0.846—0.893; wide 1.363—1.457.

Wings: forewing, long 9.25, wide 2.960; hindwing, long 9.75, wide 3.196.

Tibia iii., 1.363.

Abdomen, wide 1.55—1.64.

Soldier (Figs. 9—13.)

Colour: Head deep chrome, palpi and antennae lighter, labrum darker, anterior margin of clypeus white, mandibles black with proximal one-third much lighter; thorax and abdomen dull yellow-ochre, with a whitish median stripe from middle of prothorax to apex of abdomen, bordered on either side by an irregular brown pattern.

Head (Figs. 9 and 10) widest across the middle, slightly rounded on the sides, broadly rounded behind, with few reddish setae. Labrum acuminate. Clypeus short, and wide. Frontal opening large, its lower margin contiguous to posterior margin of clypeus. Antennae (Fig. 11) 15- or 16-jointed, 3rd joint smallest, sometimes markedly so, 4th and 5th sub-equal or nearly so.

Prothorax (Fig. 9). Margin slightly bent up, emarginate in front, the sides rounded and curving in to the rounded and slightly emarginate posterior border, rather more setose than head.

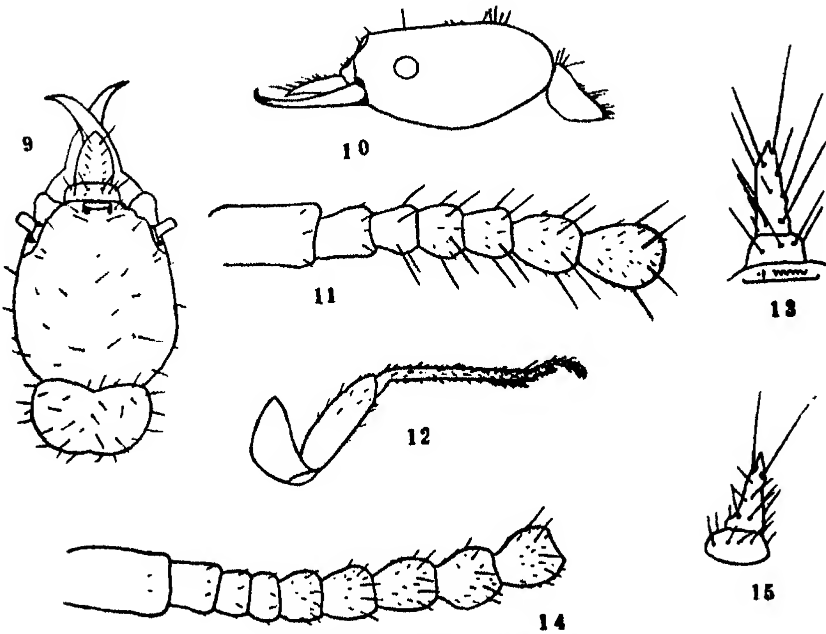
Legs (Fig. 12) moderately slender.

Abdomen elongate-oval, more pilose than thorax, with distinct median line on dorsum. Cerci (Fig. 13) moderately long (0.160) and slender. Styli short and slender, wanting in female.

Measurements:

Total length 5.5.

Head and mandibles: long 2.538—2.585.



Coptotermes raffrayi Wasman.

Text-figs. 9–13. Soldier. 9. Head and prothorax, dorsal aspect; 10. Head and prothorax in profile; 11. Antenna, proximal segments; 12. Hind leg; 13. Cercus.
Text-figs. 14–15. Worker. 14. Antenna, proximal segments; 15. Cercus.

Head: from posterior margin of clypeus to base, long 1.60; wide 1.316—1.360; deep 0.940.

Mandibles: left, long 1.128—1.175.

Clypeus: long 0.144; wide 0.384.

Labrum: long 0.432.

Prothorax: long 0.564; wide 0.987.

Tibia iii. 1.128—1.222.

Abdomen: wide 1.270.

Worker. (Figs. 14 and 15.)

Colour: Head buff-yellow, antennae slightly paler; thorax and abdomen dirty white; legs whitish, hyaline.

Head and *thorax* with scattered reddish hairs. Antennae (Fig. 14) 15-jointed, 3rd and 4th joints small, 5th rather smaller than 6th.

Abdomen moderately setaceous, with median dorsal stripe as in soldier. Cerci (Fig. 15) short, acuminate.

Measurements:

Total length 5.00.

Head: wide 1.270—1.410; from posterior margin of clypeus to base, long 1.175—1.222.

Mandibles: left, long 0.520—0.564, wide 0.420—0.470; right, long 0.470, wide 0.517.

Prothorax: long, 0.517; wide, 0.90—0.94.

Tibia iii. 1.034—1.081.

Affinities.—The imago is easily distinguished from *C. lacteus* Frogg. by its less setose, much larger and darker head (hazel in *C. lacteus* Frogg.), much darker thorax and abdomen, yellow ventral surface, much shorter and darker wings, absence of minute Y-shaped marks on wing membrane, larger abdomen. From *C. acinaciformis* Frogg. it differs still more markedly; its dark colour alone will serve to separate the species. The imago of *C. michaelseni* Silv. is not known.

The soldier caste differs from *C. lacteus* Frogg. in having a larger and darker head, reddish setae on head, thorax and abdomen (pale in *C. lacteus*), larger and darker frontal opening, darker abdomen and presence of median dorsal stripe. From *C. acinaciformis* Frogg. it differs in the above characters, except the last.

Described from a nest series of imagos, soldiers and workers, and from two series of soldiers and workers from S.W. Australia (Wonnerup, J. Clark, October, 1920; Mt. Barker, J. Clark, November, 1920; Swan River, C. F. Hill, February, 1921).

Types of imago and worker in writer's collection; co-types in Mr. Clark's collection.

All figures outlined with camera lucida. Figures 8, 13 and 15 drawn to same scale.

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ORDINARY MONTHLY MEETING.

27TH JULY, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

A card was received from Sir Hugh Dixson, returning thanks for congratulations.

The following resolution, carried at the last meeting of the Australasian Association for the Advancement of Science was read:—

"That in order to carry out immediately a co-ordinated Investigation into the Land and Freshwater Fauna and the Flora of Australia and Tasmania, the Societies and Institutions in the various States . . . be requested to cooperate in the work and to take such steps as they may deem most advisable for the carrying out of this work, more especially in securing in each State the active assistance of specialists in different branches of Botany and Zoology."

The President invited Members to discuss this resolution at the next meeting of the Society.

The Donations and Exchanges received since the previous monthly meeting (29th June, 1921), amounting to 4 vols., 65 Parts or Nos., 8 Bulletins, and 1 Pamphlet, received from 41 Societies and Institutions, and one private donor, were laid upon the table.

NOTES AND EXHIBITS.

Mr. W. W. Froggatt exhibited living larvae of a saw-fly, *Pterygophorus analis*, from Bindango Station, near Roma, Queensland, where they are defoliating thousands of ironbark trees. They then mass together at the bases of the trees, where the cattle find them and eat them. It is stated that a number of cattle have died as a result (see also These Proceedings, xliii., 1918, p. 671).

Mr. Froggatt also exhibited the foliage of a satinwood tree from Warrah, covered with galls formed by leaf mites, *Eriophites* sp. Each gall contains a dozen or more tiny, cylindrical, four-legged, reddish-brown mites clustered together in the top of the gall.

Mr. W. F. Blakely exhibited from the National Herbarium, specimens of *Helipterum uniflorum* J. M. Black (Trans. Roy. Soc. S.A., xli., 1917, p. 651) previously only known from South Australia, and now recorded for New South Wales, from the following localities: Yandalo, near Wilcannia (W. Bauerlen, Aug., 1887); Paldrumatta Bore (P. Corbett, May, 1901); Toorale-Goonery, Paroo River (J. L. Boorman, Oct. 1912). There is also a specimen in the Herbarium from Mt. Lyndhurst, S.A. (Max. Koch, No. 255, Oct., 1898). Mr.

Max Koch states that the plant is "not eaten by stock." It has the facies of *Gnaphalium indutum* Hook. f., and, unless critically examined, it could easily be mistaken for that plant.

Mr. G. H. Hardy exhibited a pair of *Allognosta fuscitarsis* Say, from Canada and United States of America. These flies were sent by Prof. M. Bezzi, and from them Mr. Hardy is enabled to state that they do not belong to the tribe *Chiromyzini*, as previously suggested by him in "A revision of the *Chiromyzini*" published in These Proceedings (xlv., 1920, p. 532).

Mr. Hardy also exhibited a pair of *Chiromyza fuscana* Wiedemann, from Paraguay, which were also sent by Prof. Bezzi; also *Chiromyza australis* Macquart, *Boreoides subulata* Hardy, and *Metoponia rubriceps* Macquart, so that *Allognosta fuscitarsis* Say could be compared with the various genera of the *Chiromyzini*.

Mr. J. J. Fletcher showed eleven complete pods, with most of the seeds still attached, of a Coral tree, *Erythrina indica*, in a garden at Hunter's Hill, supplementing an exhibit at last Meeting. These were brought down by the heavy southerly gale on June 30th.

MESOZOIC INSECTS OF QUEENSLAND.

No. 8. Hemiptera Homoptera (Contd.). The Genus Mesogereon; with a Discussion of its Relationship with the Jurassic Palaeontinidae.

By R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.L.S., F.E.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.; formerly Linnean Macleay Fellow of the Society in Zoology.

(With Plates xvi.—xxi. and seven Text-figures).

The genus *Mesogereon* was first proposed by me (1916, p. 33), for the reception of a fragment of a very remarkable forewing from the Upper Trias of Ipswich, Queensland. The name was chosen because of a certain amount of resemblance between the fragment and the well known Permian fossil *Eugereon boeckingi* Dohrn (1867), which Handlirsch (1908, p. 389) has placed alone in a new Order Protohemiptera. The name which I gave to this Upper Triassic wing-fragment was *Mesogereon neuropunctatum*, the specific name being an allusion to the remarkable formation of cross-ridges running between the main veins, and interrupted midway by an unridged area carrying strongly marked tubercles or macrotrichial sockets. This formation was interpreted as being that of a series of original cross-veins, or *archedictyon*, in process of reduction. The condition of the fossil in this respect was held to indicate that it represented an intermediate stage between Handlirsch's Fossil Order Protohemiptera and his Palaeohemiptera, and a doubt was expressed as to whether two distinct Orders should be maintained. Later evidence obtained from a study of other fossil Hemiptera has already convinced me (1918) that Handlirsch's Palaeohemiptera should be considered as only a Sub-order of the Order Hemiptera, while the Protohemiptera, as represented by *Eugereon*, stand out so distinctly that they must certainly be maintained as a good Order. *Mesogereon* itself was placed by me in the Order Protohemiptera, since it appeared probable, from the venation preserved in the fragment, that the complete wing, when discovered, might have a venational scheme not unlike that of *Eugereon*.

In the two consignments of Ipswich fossils received by me from Mr. Dunstan since my first paper was written, there is a considerable amount of material belonging to the genus *Mesogereon*. This includes no less than three forewings,

one of them in a magnificent state of preservation, and two fragments of hindwings. The type of wing represented by this material turns out to be very different from what I had surmised on the basis of the original fragment. They are evidently the wings of true Homoptera, but so unlike any known forms that I was for a long time in doubt as to where to place them, and finally decided to allot a separate Part to them, so as to allow of a full discussion of their true affinities. In this study I have had the good fortune, during my recent voyage round the world, to see for myself, and to study carefully, the types of two of the Jurassic fossils of the family *Palaeontinidae*, viz. *Palaeontina oolitica* Butler and *Eocicada lameerei* Handl., together with a number of undescribed specimens of this family from Solenhofen, which are in the Collection of the Museum of Comparative Zoology at Cambridge, Mass., U.S.A. This family has been placed by Handlirsch in the Order Lepidoptera. As will be shown in this paper, they are, as a matter of fact, a family of extinct Homoptera related to the Cicadas, as Oppenheim and Haase originally considered some of them to be. The genus *Mesogereon* is closely related to these Jurassic insects, and through them to the existing Cicadas also.

A careful study of the four forewings of *Mesogereon* (inclusive of the original fragment) shows that there are so many important differences that no two of them can be considered as conspecific. The original type of the genus, *Mesogereon neuropunctatum* Till., bears the number 19*a* of the Collection of Ipswich Fossils in the Geological Survey at Brisbane. The next specimens to be received were Nos. 206*a* and 207*a*. Of these, the former is a fairly complete forewing, with some of the apical border missing, and many of the main veins badly buckled at about two-thirds their lengths. This wing will be described as *Mesogereon affine*, n.sp. in this paper. No. 207*a* appeared to be, at first sight, an entirely different and much smaller wing. It was found only a few inches away from No. 206*a*, in the same layer of shale. After making careful drawings of this wing, which is by no means complete, I was struck with the fact that it possesses several peculiarities closely comparable with those to be found in the forewings of *Mesogereon*, and quite unlike anything else known in the Ipswich fossils. I therefore concluded that this specimen was part of the hitherto unknown hindwing of this genus. As it was found so close to No. 206*a*, I have decided to consider it as the hindwing of *M. affine*, n.sp., though, of course, it is impossible to prove this strictly, as the two wings were not attached *in situ* to the body of one insect.

Just before I left Australia in April, 1920, Mr. Dunstan forwarded me the remainder of the material dealt with in this paper. This consisted of three specimens numbered 169, 144*a* and 97 respectively. No. 169 is a magnificent wing, complete except for a small piece missing from the costal margin and another small piece from the apex. Its state of preservation is so perfect that even the impressions of some of the hairs carried by the macrotrichial sockets on the wing-membrane are visible, and have been most beautifully photographed by Mr. W. C. Davies in Plate xvii., fig. 19. The ambient vein and coriaceous border (Plate xviii., fig. 20), typical of the Homoptera, are here, for the first time, shown in their perfection, leaving no doubt as to the correct placing of these insects in the Order Homoptera. This wing is here described under the name *M. superbum*, n.sp. No. 97 is a hindwing, more complete than No. 207*a*. It shows, for the first time, a small portion of the ambient vein and coriaceous border (Plate xxi., fig. 25) resembling those of the forewing, and thus definitely settling the question as to the genus to which these two wings belong.

This wing may possibly be the hindwing of *M. superbum;* but, in the absence of any direct evidence, I have considered it necessary to give it a separate name. It will therefore be here described as *M. shepherdi,* n.sp. after Mr. S. R. L. Shepherd, an energetic officer of the Queensland Geological Survey, who unearthed many of these fossil insects. No. 144*a* is a nearly complete forewing, not very well preserved, and with the main veins somewhat crushed and compressed together. It will be described as *M. compressum,* n.sp.

The original definition of the genus *Mesogereon* given by me on the characters shown in the type fragment now appears quite inadequate, and will be greatly added to in this paper.

The photographic enlargements shown in the Plates are all the work of Mr. W. C. Davies, Curator of the Cawthron Institute, to whom my best thanks are due for such remarkably fine illustrations of these interesting fossils.

Descriptions of the Fossils.

Order **HEMIPTERA.**

Sub-order **Homoptera.**

Family MESOGEREONIDAE, fam. nov.

Large, Cicada-like insects, without sound-producing apparatus. Forewings greatly elongated, little more than one-fourth as wide as long; clavus less than one-fourth the wing-length, very narrow; rest of wing with the main veins diverging gently from one another at regular intervals across the wing; a few cross-veins present in the basal third, but the rest of the wing entirely devoid of such; ambient vein and coriaceous border complete from above apex round to distal end of clavus. Hindwings short and broad, only half as long as forewing or less; main veins diverging regularly across the wing, with no cross-veins in the distal half; ambient vein and coriaceous border present as in forewing. In the forewing, Sc, R and Rs are all placed close together near the costal border; from Cu_1 a long anterior branch (*m-cu*) arises near the base and runs distad to meet M_4 a little beyond its point of origin. In the hindwing, Sc, R and Rs are more normally placed, and *m-cu* is not elongated. Except on the clavus, which is smooth, the forewing is remarkable for the regularly arranged cross-ridges between the main veins; each of these ridges is interrupted in the middle by an area carrying strongly tuberculate macrotrichial sockets, from which stiff hairs project distad (Plate xvii., fig. 19). These structures are absent from the hindwing, which is covered all over with much finer and more closely arranged pits, each of which probably carried a very fine hair.

Closely related to the Jurassic *Palaeontinidae,* from which they differ chiefly in the shape and sculpture of the wings. Also related more remotely to the existing *Cicadidae,* in many of which the remains of the regular cross-ridging of the forewing can still be seen, but in which the main veins in the distal part of the wing are always connected by strong cross-veins.

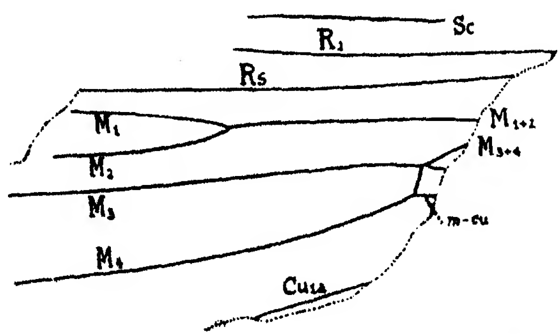
Genus Mesogereon Tillyard.

Tillyard, Mesozoic and Tertiary Insects of Queensland and New South Wales, Queensland Geol. Survey, Publ. No. 253, 1916, p. 33.

The definition of this genus can now be amended as follows:—To the characters given for the family add the following venational details:—*Forewing*: Rs arising close to base and dividing at less than one-fourth of the wing-length into

two closely parallel branches, which later on diverge somewhat towards the apex; both of these branches remain simple. M four-branched, its main stem weakly formed; M_4 arises obliquely downwards from M_{3-4} at a point nearer the base than is the forking of M_{1-2}, and shortly after receives from Cu_1 a long branch, *m-cu*, and then turns to run longitudinally in line with the course of *m-cu*. Thus between R+M and the weak main stem of M above, M_{3-4} and the basal piece of M_4 distally, and Cu_1 and *m-cu* below, a closed cell is formed, which we shall call the *medio-cubital cell*. In this cell lie the remains of an irregular and weak meshwork or archedictyon, which varies according to the species. Cu with very weak main stem, dividing quite close to the base into Cu_1 and Cu_2. Cu_1 gives off first the already mentioned branch *m-cu*, and then divides into two main branches Cu_{1a} and Cu_{1b}, both of which reach the wing-margin. Cu_2 becomes the *vena dividens*, separating the clavus from the rest of the wing, and lying in a deep groove close to 1A, except at its distal end, where it diverges from 1A considerably. Clavus with two distinct, unbranched veins, 1A and 2A, the former straight, the latter curved, and arising from the posterior border of the wing near its base. Cross-veins present are only *r-m*, the elongated *m-cu* (possibly a true branch of Cu_1), the irregular meshwork in the medio-cubital cell, and sometimes *cu-a*. *Hindwing*: Rs arising at from one-fourth to one-third along the wing, unbranched, or perhaps sometimes branched distally. M only three-branched. Cu_1 two-branched; Cu_2 a weak vein arising far along Cu, and becoming obsolete long before reaching the wing-margin. (Anal veins not well preserved, two or possibly three). Cross-veins present are only *r-m*, *m-cu* (short in this wing) and *cu-a*, with sometimes *sc-r* and another *r-m* situated more basally between the main stems of R and M.

Genotype, *Mesogereon neuropunctatum* Till. (Upper Triassic, Ipswich, Q.).



Text-fig. 65.—*Mesogereon neuropunctatum* Tillyard. **Details of venation in forewing. (x 6¾).**

MESOGEREON NEUROPUNCTATUM Till. (Pl. xxi., fig. 24; Text-fig. 65.)

Tillyard, Q'land Geol. Surv., Pub. 253, p. 34, Plate i., Figs. 1, 2.

A fragment of a forewing, measuring 23 mm. greatest length by 17 mm. greatest breadth. Studied in the light of the new material, this fragment is found to consist of a small portion of a very large wing, probably between 50 and 60

mm. long and with a greatest breadth of 15 mm. or more. Portions of all the veins from Sc to Cu_{1b} are preserved, but the wing is broken about the middle of the preserved portion of Sc, so that this vein, R_1, Rs, M_1 and M_2 are all badly bent. Origin of Rs not visible. Forks of M_{1-2} and M_{3-4} are both clearly preserved, the distance between them being 4 mm. The bent basal piece of M_4 lies just within the basal edge of the fragment, and is 0.6 mm. long. These measurements are useful for comparison with the wings of the other species. In Fig. 1 of my original description of this wing, the vein marked C is Sc, Sc is R_1, R is Rs, the two veins marked M are M_1 and M_2 respectively, while the two marked Cu are M_3 and M_4. Below these, crossing the posterior angle of the fragment, are a shorter piece of Cu_{1a}, and a minute portion of Cu_{1b}, the latter labelled A in the figure.

The cross-ridging of the main veins, and the tuberculated areas lying between them, are fairly well shown, as may be seen from a study of Plate xxi., fig. 24, of this paper.

Type, Specimen No. 19*a*, in Coll. Queensland Geol. Survey, Brisbane, Q. *Type-counterpart*, Specimen No. 19*b* in same collection.

Horizon, Upper Triassic, Ipswich, Q.

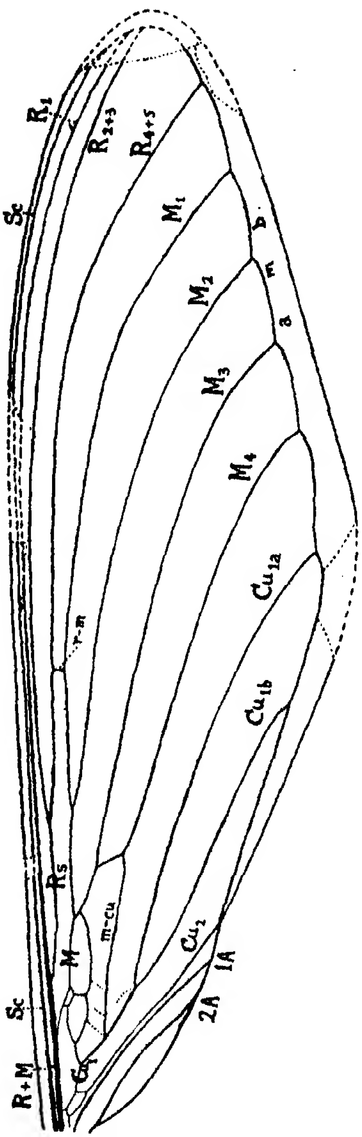
MESOGEREON SUPERBUM, n.sp.

(Text-figs. 66, 67, and Plates xvi., xvii., xviii., Figs. 18—20.).

A remarkably preserved forewing, complete except for a portion of the costal margin and a small piece missing from the extreme tip. *Greatest length*, 44.5 mm., representing a wing about 46 mm. in total length. *Greatest breadth*, 12 mm., which is also the greatest breadth of the complete wing.

The scheme of the venation is shown in Text-fig. 66. The wing is long and narrow, the costal margin straight from base to half-way, and then very slightly convex. The extreme apex is missing, but appears to have been moderately rounded, or perhaps very slightly pointed. Posteriorly, the wing margin shows a very obtuse angulation about half-way, this angle being the *tornus*, separating the true *dorsum*, or basal portion of the posterior margin, from the *termen*, or part lying between apex and tornus. R_{2-3} runs to apex, and Cu_{1a} ends up just above the tornus. Sc and R_1 are crowded together close up to the costal margin for their whole lengths, diverging very slightly indeed towards the apex. R and M are fused together for a short basal stretch, after which M separates off as a very weakly indicated vein, supported beneath by the irregular meshwork of the medio-cubital cell described below. A little beyond the origin of M, Rs separates off from R as a strong vein running just below R_1, and dividing into R_{2-3} and R_{4-5} at a point about one-fourth of the wing-length from the base. R_{2-3} runs close under R_1 for some distance, then diverges very slightly from it in the distal half of the wing, and finally converges towards it again very slightly near the apex, where it ends. This vein remains unbranched throughout. R_{4-5} diverges slightly from R_{2-3} at its origin, and then runs sub-parallel to it for about half its length. More distally, it diverges considerably from R_{2-3}, and ends up some distance below the apex. At about two-fifths of the wing-length from the base, R_{4-5} is connected with M_1 by a short but well marked crossvein, *r-m;* slightly basad from this there is an appearance of a second, much more weakly formed cross-vein, indicated by the dotted line in Text-fig. 66.

At about one-fifth of the wing-length from the base, M forks dichotomically into two main branches. The upper of these, M_{1-2}, runs to a point just distad



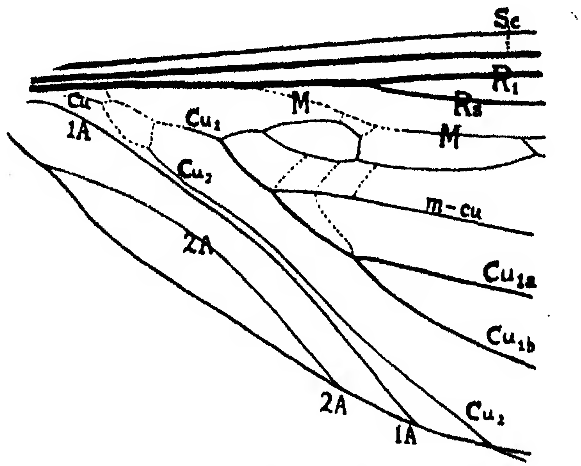
Text-fig. 66.

Mesogereon superbum, n.sp.
Venation of forewing. (x 3½).

from the level of the origin of Rs, and then forks again dichotomically into M_1 and M_2. The lower, M_{3-4}, runs only about half the distance of the upper, and then forks uniserially, M_3 continuing the line of M_{3-4}, while M_4 diverges sharply posteriad for a short distance, until it meets a longitudinal branch from Cu_1 (*m-cu*); it then turns distad so as to continue the line of *m-cu*. From this point on, the wing is divided evenly by the series of very slightly diverging veins M_1, M_2, M_3 and M_4, with the branches of Rs continuing the series anteriorly, and the branches of Cu_1 posteriorly. Distance between fork of M_{1-2} and fork of M_{3-4}, 2.5 mm.; length of basal piece of M_4, 1.2 mm. The *medio-cubital cell* is closed basally by a short weak cross-vein descending from R+M on to the very weakly formed main stem of Cu (both of these being barely visible), and ends distally at the basal piece of M_4. Within it is to be seen the peculiar and very irregular formation of veinlets shown in Text-fig. 67. These consist of a fairly strongly marked curved longitudinal vein running from Cu_1 very close to the base to join M_{3-4} slightly distad from its origin. This vein is divided, just before half-way, by a transverse vein above it, which forms the distal boundary of a small closed cell lying just below M, and connected with it by two very short and weak cross-veins; the small cell is completed by a convex vein above, arising from the long vein already mentioned at a point slightly distad from its origin. Below this small cell are two oblique cross-veins, weakly formed, with a third similar cross-vein descending from the long vein on to *m-cu* just distad from them. This peculiar formation should be compared with the simpler formation to be met with in the same area of *M. affine*, n.sp.

The very weakly formed basal piece of Cu forks quite close to the base into Cu_1 and Cu_2 (Text-fig. 67), both of these being weakly indicated for a short distance, until they are connected by a weak cross-vein. Beyond that point, they begin to strengthen, Cu_1 soon becoming a very strong convex vein, which

gives off, anteriorly, the long connecting vein *m-cu*, already mentioned in connection with M_4, and then divides into Cu_{1a} and Cu_{1b} at a point level with the origin of Rs; these two veins run in a gentle curve to the wing-border, Cu_{1a} ending up above the tornus, Cu_{1b} more basally on the dorsum. Cu_2 lies in a deep groove in the anal furrow, forming the *vena dividens*, with its apex at the termination of the *coriaceous border*.



Text-fig. 67.—*Mesogereon superbum*, n.sp. Venation of base of forewing. (x 6½).

The *clavus* is short and narrow, ending distally at a point about level with the first forking of M. There are only two anal veins, of which 1A is nearly straight, and runs very close up to Cu_2, except distally, where these two veins diverge, while 2A forms a very flat loop, arising and ending on the posterior border of the clavus.

The whole of the wing between the radius and the clavus carries the cross-ridges and flat tuberculated areas typical of the family. These are well shown in Mr. Davies' beautiful photographs reproduced in Plates xvi.—xviii., figs. 18, 19, 20. That the tubercles were the swollen sockets of macrotrichia is well seen by a study of the enlargement in Plate xvii., fig. 19, in which the impressions of the hairs can be very clearly seen, especially in the forks between $M_{1\text{-}2}$ and M_3, and between M_3 and M_4.

From just above the apex of the wing right round the termen and dorsum to the distal end of the clavus, there is a well preserved *coriaceous border*, separated from the rest of the wing by the *ambient vein* (*amb.*). This border shows a definite cross-ridging of considerably smaller calibre than that shown along the main veins, as may be seen from a study of Plate xviii., fig. 20. The coriaceous border in the wings of recent *Cicadidae* shows a similar cross-ridging, but the ridges stand much further apart. The ambient vein (*amb.*) forms a series of slight bays between the ends of each pair of consecutive main veins, much as in the case of recent *Cicadidae*, but with the individual bays not so strongly formed.

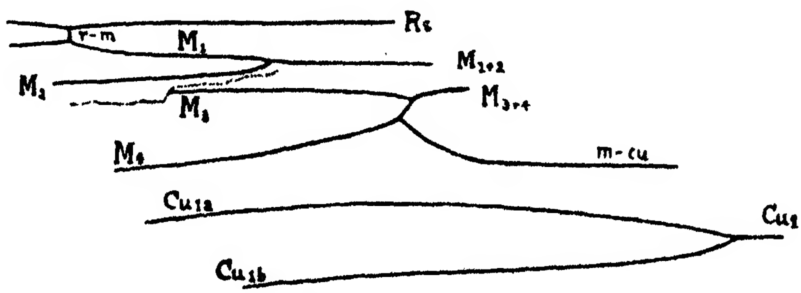
Type, Specimen No. 169, in Coll. Queensland Geol. Survey, Brisbane, Q.
Horizon, Upper Triassic, Ipswich, Q.

Of all the fossils so far found at Ipswich, this wing is perhaps the most perfectly preserved as regards the minute structure of the veins and membrane.

MESOGEREON COMPRESSUM, n.sp. (Text-fig. 68.)

A nearly complete but very poorly preserved forewing, in which the longitudinal veins have been compressed together to some extent, especially from the costa down to M_3. *Greatest length,* 42 mm., representing a total length of about 45 mm. *Greatest breadth,* only 8 mm., representing a true wing-breadth of about 12 mm.

The extreme base of this wing is missing, owing to a diagonal break from near the base of *m-cu* up to and including the first fork of M. The whole of the clavus is absent, and also a narrow strip along the termen, including the coriaceous border. Text-fig. 68 shows a portion of the wing, including the cross-vein *r-m* and the forks of M_{1-2}, M_{3-4} and Cu_1. The cross-vein *r-m* is very short, each of the two main veins Rs and M_1 being curved in slightly at this point, and then diverging slightly again distad. As a result of compression, together with, per-



Text-fig. 68.—*Mesogereon compressum*, n.sp. Details of venation of forewing. (x 6¾).

haps, a longitudinal split, the space between M_2 and M_3 has become greatly lessened; and M_3, lying at a lower level than M_2 on the rock surface, disappears under the slight ridge on which this latter vein lies. Distance between fork of M_{1-3} and fork of M_{3-4}, 2.9 mm. (possibly a little more in the uncompressed wing); length of basal piece of M_4, 0.6 mm. Cross-ridges clearly marked, tuberculation weak.

T y p e, Specimen No. 144*a*, in Coll. Queensland Geol. Survey, Brisbane, Q. *Type-counterpart,* specimen No. 144*b*, in same collection.

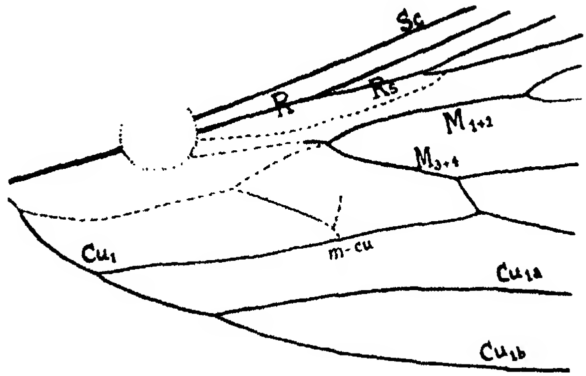
H o r i z o n, Upper Triassic, Ipswich, Q.

MESOGEREON AFFINE, n.sp. (Text-figs. 69, 70, Plates xix., xx., Figs. 21, 22.)

Specimen No. 206*a* represents a nearly complete forewing with most of the termen missing, and with all four branches of M broken along an oblique line in the distal part of the wing, so that their distal ends bend downwards at a well marked angle. *Greatest length* of fragment, 35 mm., representing a total length of wing of about 40 mm. *Greatest breadth,* 11.5 mm., representing a total width of about 12 mm.

Text-fig. 69 shows the well preserved basal portion of this wing, excluding the clavus. A small round hole made by a sharp instrument near the base of R is indicated by the finely dotted circle. It will be seen that the origin of

Rs is at the same level as the first fork of M, while the fork of Rs is at the same level as the origin of M_4. Distance between fork of M_{1-2} and fork of M_{3-4} 2.5 mm.; length of basal piece of M_4, 1.2 mm. In the medio-cubital cell, the



Text-fig. 69.—*Mesogereon affine*, n.sp. Venation of base of forewing. (x 6·4).

remains of the archedictyon consist only of the long vein running from near the base of Cu_1 to the fork of M, together with a vein descending obliquely from it on to *m-cu;* from near the lower end of this latter vein, a short broken stump runs upwards towards M_{3-4}, but ends half-way across the cell. There is also a weakly formed veinlet running longitudinally in the space between R and M, and ending on Rs just distad from its origin. Cross-ridging very distinct; tuberculation moderately well preserved.

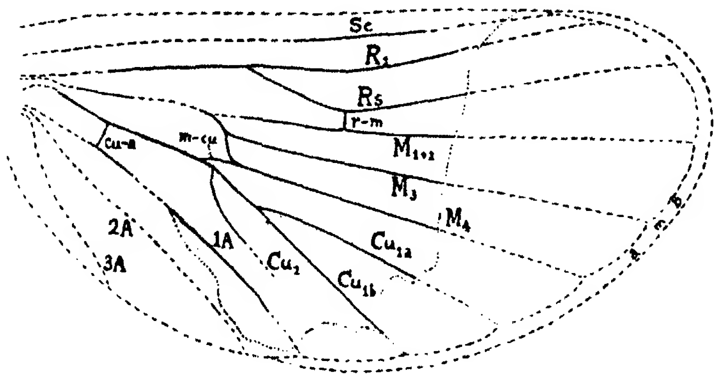
Type, Specimen No. 206*a*, in Coll. Queensland Geol. Survey, Brisbane, Q. *Type-counterpart*, specimen No. 206*b*, in same collection.

Horizon, Upper Triassic, Ipswich, Q.

Specimen No. 207*a* was found not far from No. 206, and is shown in Plate xx., fig. 22. Text-fig. 70 shows a drawing of the preserved parts of the venation, with the rest of the wing restored by broken lines. The close resemblance to the venation of the hindwing of a Heteroneurous Moth will be at once evident. I was for a long time in doubt as to whether this wing did not really belong to the Lepidoptera. The absence of any portion of the termen, from which it might be determined whether a coriaceous border was present or not, made the problem a difficult one. But finally a portion of the border was discovered in another closely similar hindwing (No. 97). This discovery made it certain that both specimens No. 97 and No. 207*a* were hindwings belonging to the genus *Mesogereon*. Specimen No. 207*a* is here considered to be the hindwing of *M. affine*, as it was found so close to the forewing of that species.

Comparing the hindwing with the fore, it will be seen at once, from the more normal positions of Sc and R, that the hindwing was considerably broader than the fore in comparison with its length. The preservation of part of the distal border in No. 97 enables us to estimate very closely the actual shapes of these wings, which are then seen to bear very much the same relationship to the forewings that those of a recent Cicadid do to their corresponding forewings. Rs arises a little beyond one-third of the wing-length, and runs obliquely downwards

until, at about half-way along the wing, it is joined to M_{1-2} by the short cross-vein *r-m*, closely resembling that of the forewing. The basal part of M is weakly formed; it divides unilaterally into M_{1-2} above, continuing the course of M, and M_{3-4} below; this latter vein proceeds obliquely downwards a very short distance, and then divides into M_3 and M_4, the former running straight through the wing to



Text-fig.70.—*Mesogereon affine*, n.sp. Venation of hindwing. Missing portions restored by broken lines. For lettering, see p. 284. (x 4½).

the middle of the termen, the latter curving downwards to meet a short branch from Cu_1 (*m-cu*), and then turning to run sub-parallel to and beneath M_3 to the termen. Cu is clearly marked, and is joined to 1A by means of a strong cross-vein *cu-a*. What appears to be the true Cu_2 is a weakly formed furrow-vein arising just beyond the origin of *m-cu*, and soon becoming obsolescent; it fails to reach more than half-way to the wing-border. Cu_1 continues the line of Cu with a slight bend downwards, and soon forks into Cu_{1a} and Cu_{1b}, which diverge to run straight to the wing-border. 1A appears to be well developed; the rest of the clavus is missing. *Greatest length*, 11 mm. *greatest breadth*, 9 mm., representing a wing of about 21 mm. total length by 11 mm. breadth.

This wing is very finely pitted all over, each minute pit having been apparently the socket of a small hair. There are no cross-ridges on the main veins.

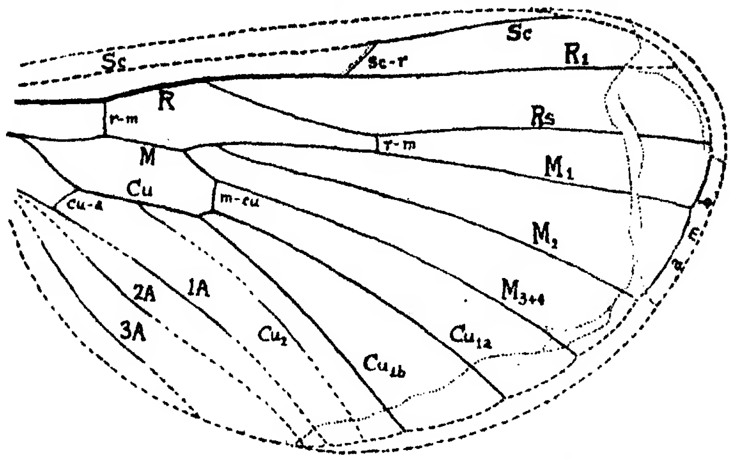
Type, Specimen No. 207*a*, in Coll. Queensland Geol. Survey, Brisbane, Q. *Type-counterpart*, specimen No. 207*b*, in same collection.

MESOGEREON SHEPHERDI, n.sp. (Plate xx., Fig. 23, and Text-fig. 71.)

This species is represented by a hindwing only, complete except for the absence of the costal border, a small piece around the apex, the lower portion of the termen, and most of the clavus. *Greatest length*, 21 mm., *greatest breadth*, 11 mm., the former representing practically the full length of the wing, the latter indicating a total breadth of about 13 mm.

Structure and venation generally similar to those of the hindwing of *M. affine* described above, but with the following differences:—R is connected with M close to the base by a strong cross-vein, *r-m*. About half-way along the wing, R is also connected with Sc by an oblique cross-vein, *sc-r*. Rs arises closer to the base than in *M. affine*, but the cross-vein *r-m* which corresponds with that in *M. affine* remains in the same position about half-way along the wing; consequently the piece of Rs from origin to cross-vein is longer in *M. shepherdi*, and

the bend at the cross-vein less marked. M is three-branched, but it is the upper branch, M_{1-2}, which divides into two, while the lower, M_{3-4}, appears to run straight to the termen. Cu_1 divides into two at a level slightly distad from that



Text-fig. 71.—*Mesogereon shepherdi*, n.sp. Venation of hindwing. Missing portions restored by broken lines. For lettering, see p. 284. (x 4½). Note the presence of two radio-median crossveins, *r-m*.

of the first fork of M; the upper branch, Cu_{1a}, is connected with M_{3-4} by a strong cross-vein. (It would be possible to interpret this cross-vein as the basal piece of M_4; in which case M would become four-branched and Cu_1 simple in this species; it is not easy to say which interpretation is really the correct one). The origin of Cu_2 is not clear, but appears to be about half-way between *cu-a* and the forking of Cu_1. The cross-vein *cu-a* is present near the base, but somewhat more oblique than in *M. affine.*

Cross-ridges are absent on the main veins, but clearly present on the coriaceous border, a portion of which is preserved between the ends of veins Rs and M_2. This part of the wing is shown much enlarged in Plate xxi., fig. 25.

T y p e, Specimen No. 97 in Coll. Queensland Geol. Survey, Brisbane, Q.

H o r i z o n, Upper Triassic, Ipswich, Q.

Table of Some Important Differences in the Forewings of the Known Species of Mesogereon.

	Measurements (in mm.).	*M. neuropunctatum.*	*M. superbum.*	*M. compressum.*	*M. affine.*
(1).	Estimated total length.	50 - 60	46	45	40
(2).	Estimated total breadth.	15 - 17	12	12	12
(3).	From fork of Rs to fork of M_{1+2}.	—	0·9	—	2·3
(4).	From fork of M_{1+2} to fork of M_{3+4}.	4·0	2·5	2·9	2·4
(5).	Basal piece of M_4.	0·6	1·2	0·6	0·9
(6).	Angle of M^4 to fork of Cu_1.	—	5·7	6·3	6·0
(7).	Ratio of (4) to (5).	6·7	2·1	4·8	2·7
(8).	Ratio of (6) to (5).	—	4·7	10·5	6·7

Discussion of the Relationship of the Genus Mesogereon with the Jurassic Palaeontinidae.

In my work on the Panorpoid Complex, I followed Handlirsch in considering the Jurassic family *Palaeontinidae* as belonging to the Order Lepidoptera (1908, pp. 654-8). I pointed out, however, certain characters which prevented us from assigning them to either of the two Sub-orders of the Lepidoptera existing to-day, and suggested that they should be considered as a separate Sub-order Palaeontinoidea.

It is, of course, well known that both Oppenheim (1888) and Haase (1890) considered certain of the *Palaeontinidae* which they described to be Homoptera related to the *Cicadidae;* viz., the genera *Prolystra, Beloptesis* and *Eocicada.* Others were placed in the Lepidoptera, viz. *Phragmatoecites* and *Palaeocossus.* Butler placed the well known forewing of *Palaeontina oolitica* in the Lepidoptera. Thus there was, from the first, considerable doubt about the correct position of these fossils. Handlirsch, after studying many of the type-specimens and describing other new species, summed up his conclusions as follows (1908, p. 619, translated from the original German):—

(1) In several of these fossils the covering of scales on the wings is quite plainly visible.

(2) The *Limacodidae* just mentioned do not visit flowers, and are, no doubt, old forms whose mouth-parts remain at an archaic stage of development, similar to the *Hepialidae,* etc, (N.B. Handlirsch claims a close affinity between the *Palaeontinidae* and the existing *Limacodidae.*).

(3) The resemblance of these fossils to the Cicadas is only a very superficial one, and their venation can in no way be traced back to that of the Homoptera.

(4) The venation of the fossils is strikingly similar to the course of the tracheae in many pupae of recent Lepidoptera.

At the time when I discussed this family in the Panorpoid Complex, I had not, of course, seen any of the actual fossils, and had been content to accept Handlirsch's statement, that the covering of scales could be quite plainly seen in some of them. However, during my recent voyage round the world, I studied all those *Palaeontinidae* to which I could get access, and was surprised to find myself quite unable to agree with Handlirsch's conclusions. The results which I obtained may be briefly stated as follows:—

(1) The original type of *Palaeontina oolitica* Butler was studied by me in the Geological Museum, Jermyn Street, London. This is a very badly preserved impression of a forewing, from which it would be quite unsafe to draw any definite conclusions. It is clear, however, that M has four quite distinct branches, which occupy most of the distal portion of the wing, so that the branches of R, which are indistinct, are pushed up towards the costal margin. There is no sign of the formation of a Y-vein between M_4 and Cu_{1a}. Thus, in so far as this specimen offers any evidence at all, it is *not* in favour of any Lepidopterous affinity. (No sign of scales can be seen, but this could not be expected in so poorly preserved material.).

(2) Professor Lameere, of Brussels, kindly handed to me for study the original type of *Eocicada lameerei* Handl. With respect to this insect, Handlirsch has stated definitely that he could see the scales on the wings (1908, p. 627, "Am mehrerer Stellen haben die Schuppen ganz deutliche Eindrucke auf der Platte hinterlassen"). The specimen is only moderately well preserved, like most of the insects from the Solenhofen Beds. Handlirsch's photographic repro-

duction (1908, Atlas, Plate 1, fig. 11) scarcely does justice to it, and a careful study of the fossil under low powers of the microscope soon reveals some characters of unexpected interest. With respect to the wings, I searched most carefully for evidence of scales all over them, but have to confess that I could see no sign of them, though the peculiar semi-glazed and flattened grain of the rock might mislead one into thinking that scales were present. But I did discover, in a number of places, distinct evidence of the presence of comparatively large tubercles in the areas midway between the main veins. These tubercles closely resemble those of *Mesogereon* in size, number and arrangement. The fact of their presence makes it quite certain that scales are *not* present. I next searched for signs of the transverse ridging of the main veins, but failed to find any indication of this. Finally, following round the margin of the forewing, I looked carefully for signs of a coriaceous border, with the result that I am able to state definitely that such a border did exist in this fossil, as clear signs of it can be seen in several places, by the use of careful lighting. Turning next to the body, it was possible to make out fairly definite indications of hairiness on the abdomen. The head is certainly not as small as Handlirsch supposes. The part which he takes for the whole head is only a small projecting frontal shelf, much like that of recent Cicadas. On either side of this there can be seen a largish oval depression, which is surely that of the compound eye. These two eyes, then, are large and stand wide apart, like those of recent Cicadas. Projecting on either side between the eye-depression and the frontal shelf, there can be seen faintly a short projecting filament, which is almost certainly the impression of the antenna, and corresponds exactly in shape and position with the antenna of a true Cicada.

The venation of this fossil, as far as it is preserved, closely resembles that of *Mesogereon*. Sc and R are pressed close up towards the costal margin, while little space is allotted for Rs, and there is certainly no justification for the restoration of the full four branches of Rs apically, as Handlirsch has shown them. Most of the distal area of the wing is occupied by the four very prominent branches of M, very similar to those of *Mesogereon*. M_4 has a short basal piece, and is then bent, as in *Mesogereon*, at the point where it receives a long branch from Cu_1 (the branch which I have called *m-cu*). Cu_1, after giving off *m-cu*, branches again into Cu_{1a} and Cu_{1b}, exactly as in *Mesogereon*. The hindwing is greatly reduced and poorly preserved. Two forked veins can be seen, separated by a single vein. The single vein is clearly a part of M, the main stem of this vein being clearly visible. If this vein be M_{3-4}, then the forked veins above it are probably M_1 and M_2, as in *Mesogereon shepherdi*. The forked veins below M_{3-4} are evidently Cu_{1a} and Cu_{1b}, as in *Mesogereon*.

As regards Handlirsch's remark that the venation of *Palaeontinidae* resembles the courses of the tracheae in pupal wings of recent Lepidoptera, it might with more than equal truth be said that they also resemble the courses of the tracheae in the nymphal wings of recent Cicadas.

From my study of *Eocicada lameerei*, I am forced to conclude that this fossil is a Homopteron, closely related to *Mesogereon* and less closely to the recent *Cicadidae*.

(3) There are, in the Museum of Comparative Zoology at Cambridge, Mass., a whole drawer full of Solenhofen fossils belonging to the *Palaeontinidae*. These are undescribed, but classified as Hemiptera. These fossils would well repay a fuller study than I was able to give them. Although for the most part in poor preservation, it is possible to find in them plenty of evidence in support of the Homopterous nature of the *Palaeontinidae*. None of them shows signs of scales,

but the tuberculation of the forewing is faintly indicated in places, and so is the presence of the coriaceous border.

Reviewing the above evidence as a whole, I am forced to the conclusion that Handlirsch has committed a serious error in claiming that the *Palaeontinidae* belong to the Lepidoptera, and more particularly in making the definite statement that scales are to be seen on these fossil wings. As far as the material which I studied can be considered typical of the family, there is certainly no evidence of any Lepidopterous affinities. On the contrary, the general build of the insects, the venational scheme, and what little can be discovered of the armature of the wing and the structure of the margin, leave no doubt whatever in my mind that the *Palaeontinidae* are closely related to the genus *Mesogereon*, and that both have a less close connection with recent *Cicadidae*. Though it is not possible to prove definitely that either *Mesogereon* or the *Palaeontinidae* represent the original ancestors of the Cicadas, yet we can definitely state that those ancestors must have closely resembled these fossils.

Present knowledge of the genus *Mesogereon* would lead me to abandon my former claim that they show any affinity with the Protohemiptera, as represented by *Eugereon*, though I am still prepared to see, in the cross-ridging of the main veins and the presence of a remnant of an archedictyon in the medio-cubital cell, evidences of a descent from forms possessing a complete original mesh work of weak veinlets, such as is found in most of the Carboniferous fossils.

A restoration of the complete insect belonging to the genus *Mesogereon* should show it as a Cicada-like insect having roughly-haired forewings held roof-wise over a moderately stout and probably hairy body; the hindwings smooth and transparent, hidden beneath the forewings, and probably with the anal area folded. There was no sound-producing apparatus comparable with that of recent Cicadas. The voiceless, hairy Cicadas of the genus *Tettigarcta*, confined at the present day to Victoria and Tasmania, perhaps represent the closest approach, amongst living insects, to these interesting Upper Triassic fossils, whose discovery cannot fail to add much to our knowledge of, and interest in, the Homoptera as a whole.

Cawthron Institute, Nelson, N.Z. 7.3.21.

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Note on the numbering of the figures.—The numbers of the figures in this series of papers were intended to run consecutively from Part to Part. Owing to

an inadvertence, the Text-figures of Part 7 were not so numbered. Forty should be added to the number of each Text-fig. in Part 7, so that the last one is 64, not 24. Thus this Part begins with No. 65. In the same way, the figure on the Plate accompanying Part 4 should be number 15, and the two figures on the Plate issued with the Queensland Geological Survey reprints of Part 5 should be Nos. 16 and 17.

EXPLANATION OF PLATES XVI.-XXI.

[All the plates are reproductions of photographic enlargements taken by Mr. W. C. Davies, Curator of the Cawthron Institute, by means of vertical camera extending to 42 inches, Aldis anastigmat lens (F 6·5, No. 00), and nearly horizontal electric light with condenser].

Plate xvi.

Fig. 18. *Mesogereon superbum*, n.sp. Forewing. (x 4·1).

Plate xvii.

Fig. 19. *Mesogereon superbum*, n.sp. Base of forewing. (x 10·9).

Plate xviii.

Fig. 20. *Mesogereon superbum*, n.sp. Portion of forewing, much enlarged, to show ambient vein and coriaceous border. (x 16).

Plate xix.

Fig. 21. *Mesogereon affine*, n.sp. Forewing. (x 5·65).

Plate xx.

Fig. 22. *Mesogereon affine*, n.sp. Hindwing. (x 5.6).
Fig. 23. *Mesogereon shepherdi*, n.sp. Hindwing. (x 5).

Plate xxi.

Fig. 24. *Mesogereon neuropunctatum* Tillyard. Genotype. Fragment of forewing. (x 8).

Fig. 25. *Mesogereon shepherdi*, n.sp. Portion of hindwing, much enlarged, to show a piece of the ambient vein and coriaceous border. (x 16).

LETTERING OF TEXT-FIGURES.

1A, 2A, 3A, the three anal veins. *amb*, ambient vein. Cu, cubitus. Cu_1, Cu_2, its two main branches, the former dividing into Cu_{1a} and Cu_{1b}. *cu-a*, cubito-anal cross-vein. M, media. M_{1+2}, M_{3+4}, its two main branches, of which the former divides into M_1 and M_2, the latter into M_3 and M_4. *m-cu*, medio-cubital cross-vein (in forewings of *Mesogereon* this is much elongated, and may be a true anterior branch of Cu1). R, radius. R_1, its anterior main branch. Rs, its posterior main branch, or *radial sector*, which divides into R_{2+3} and R_{4+5}. *r-m*, radio-median cross-vein (there are two of these in hindwing of *M. shepherdi*, n.sp.). Sc, subcosta. *sc-r*, subcosto-radial cross-vein.

[Printed off 4th August, 1921.]

A PRELIMINARY REVISION OF SOME GENERA BELONGING TO THE DIPTERA BRACHYCERA OF AUSTRALIA.

By G. H. Hardy.

(Sixteen Text-figures.)

The chief purpose of this paper is to define some genera of the *Diptera Brachycera*. Hitherto, many of these genera were based upon individual species and some specific characters were used for generic determination, or else a number of heterogeneous species were grouped together under one generic name as they possessed in common some character of but trivial importance.

No attempt has been made to establish synonymy amongst genera having characters identical with those given in this paper, as further study may yet elucidate discriminative characters.

A study of the antennae of species belonging to the subfamily *Dasypogoninae* has provided new characters of generic value, and an entirely new interpretation is given to those characters which were previously published.

New species are only described where they are required to illustrate remarks and criticisms made under their respective genera and new synonyms to species are recorded wherever found.

The outlines of the revised taxonomy proposed here were based upon the study of various collections, the most important of which are in the Macleay, Australian and Queensland Museums, and in the Agricultural Department of Queensland. Various private collections, including that of Dr. E. W. Ferguson, were also examined.

Acknowledgements.—Much of this paper was based upon facts gathered together during the preparation of my previous papers and consequently the same sources of help are again gratefully acknowledged. In addition, thanks are due to Mr. H. A. Longman, Director of the Queensland Museum, and to Mr. Henry Tryon, Entomologist of the Agricultural Department, Queensland, for permission, so readily granted, to examine the collections under their charge.

Family LEPTIDAE.

Note.—White (1914) proposed the genus *Clesthentia* which he placed in the *Leptidae*. Subsequently it was revised, still under this family, by me (1919). A further study of the genus has convinced me that White misplaced his typical species which has characters that conform better to those of the family *Therevidae*, under which see further remarks.

Genus Spaniopsis White.

Types.—In 1915, under this genus, Dr. E. W. Ferguson described four species of flies, the holotypes of which were stated to be in the Microbiological Laboratory of the Department of Public Health. While Dr. Ferguson was absent on war-work in Europe, these specimens were attacked by *Anthrenus* and now only two holotypes are left, both of which have since been placed in the Australian Museum, where they will have the advantage of being continuously under the charge of an entomologist.

In 1919, in a paper "The Australian Rhyphidae and Leptidae" I based the identity of species, described by Dr. Ferguson as belonging to this genus, upon the paratype material in the Australian Museum as the types, then in the Health Department, were not available.

The following list of specimens in the Australian Museum contains all those deposited there that were used in various papers dealing with this genus.

S. tabaniformis White; holotype and one paratype.

S. vexans Ferguson; (holotype lost); two paratypes and one other specimen. (Possibly this is not specifically distinct but represents a smaller form of the previous species).

S. clelandi Ferguson; holotype, two paratypes and one other specimen.

S. marginipennis Ferguson; holotype, one paratype and four other specimens.

S. longicornis Ferguson; (holotype lost); one paratype and two other specimens.

Distribution.—This genus has evidently a wide distribution over Australia, as there are specimens from Western Australia in the Macleay Museum. Also Dr. Ferguson has recently received specimens from that State. The various species appear to be met with most frequently in June, and I have taken as many as three of them during one day in a small part of a valley at Heathcote, New South Wales, where they were swarming, not only in the valley, but also on the summit and slopes of the hills on each side.

On the same occasion I swept bushes in the endeavour to secure males but failed to find any specimens showing characters of a secondary sexual nature.

There are some males however from Western Australia in the Macleay Museum, and they have contiguous eyes.

Family ASILIDAE.

Notes.—Miss Ricardo's revision (1912-13) of the Australian *Asilidae* does not contain a revision of the genera into which the species were placed, and the new genera she proposed lack characters by which they can be adequately defined. Her keys to the genera contain characters of specific value and her arrangement of these is misleading.

Two of the four subfamilies of the *Asilidae* are revised here and the majority of the genera within them are defined. The definitions are based upon Australian material and, wherever possible, on the typical species.

Subfamily DASYPOGONINAE.

Notes.—The number of genera indigenous to Australia belonging to this subfamily exceeds those in the other three subfamilies of the *Asilidae* together. They have been so poorly studied that scarcely any definitions are to be found in the literature and, as most of the genera appear to be restricted to Australia

or the Australian region, little assistance for determining them is to be found in the works on the *Asilidae* of other countries.

In this revision, primary characters only are dealt with and these group the genera into convenient sections. The characters differentiating the genera within these sections will be found under their respective generic headings.

The exoskeleton shows differences of generic value in the characters discussed below.

Antennae. The antennae contain three joints and an appendage of one or two vestiges of joints. These vestiges have been called the style and the first may be absent; the second vestige is invariably indicated, often very minutely so, and it is spine-like.

A study of the antennae of the various genera of the *Dasypogoninae* has convinced me that the first vestigial joint, which is sometimes long and conspicuous, should be called the fourth joint, and the second spine-like vestigial joint should be called the fifth.

If the fourth joint becomes obsolete, by being amalgamated with, or in any other way indistinguishable from, the third, then the fifth joint will appear to be on the third, usually in the form of a spine.

Invariably the fifth joint is indicated; either it is contained within a depression on the extreme apex, as illustrated in Text-figures 3, 5, 6 and 7, or it is contained within an apical incision placed dorsally and occurs either on the fourth joint or on the third, as illustrated in Text-figures 4 and 8 respectively. Sometimes the fifth vestigial joint is obscure and difficult to find.

Thorax. Two genera have a pair of spines on the thorax, one placed on each side, a little above the wings. This character appears to be most important, as the species which possess it also have an elongate neck and the wings placed well beyond half the length of the thorax (Text-fig. 1); these characters give the species the very characteristic appearance they all possess.

Legs. The anterior tibiae in some of the genera contain a spur at the apex. This spur has been used to divide the genera into two groups, in one of which the spur is missing, but in this paper the character is derogated to a position of less importance.

Wings. The venation is somewhat variable, even within a species, but in a few genera the fourth posterior cell is closed considerably before the wing margin. In the remaining genera it is open, or at most closed on the wing margin. The character appears to be important and is here placed second in value to that of the thoracic spines.

Key to the genera of the Dasypogoninae.

1. Thorax with a pair of lateral spines, one placed on each side a little above the wings 2
   Thorax without such spines 3
2. Antennae with a two-jointed style consisting of the fourth and fifth antennal joints .. .. *Chrysopogon*
   Antennae with a one-jointed style consisting of the fifth antennal joint in the form of a strongly developed apical spine .. .. *Opseostlengis*
3. Wings with the fourth posterior cell closed considerably before the wing margin 4
   Wings with the fourth posterior cell open, or at most closed on the wing margin 5

4. Antennae with a conspicuous fourth joint .. .. *Phellus; Psilozona*
Antennae with only three joints and a spine (the fifth) . .. . *Bathypogon; Deromyia*
5. Antennae with the fourth joint present 6
Antennae with three joints and a small or minute spine 7
6. Anterior tibiae with an apical spur .. .. *Erythropogon; Saropogon*
Anterior tibiae without a spur .. .. *Neodioctria; Stenopogon; Cryptopogon*
7. Anterior tibiae with an apical spur .. .. *Neosaropogon; Neocyrtopogon; Cabasa; Brachyrrhopala*
Anterior tibiae without a spur .. .. *Codula*

A definition of the genus *Rachiopogon* cannot be given here. The typical species is represented in the collection of the Agricultural Department of Queensland but, unfortunately, it was examined before the study of the antennae was made and the species is not available at the time of writing this paper.

The genera *Acnephalum* and *Microstylum* have not been recognised in the collections examined. They should belong to the *Phellus-Bathypogon* group.

The antennae of the genus *Damalis* have a terminal arista, a character which has not been recognised in the Australian species.

According to Lundbeck (1908) the genus *Dasypogon* has a tibial spur, a one- or indistinctly two-jointed style with a bristle-shaped apex, and the posterior cells all open. It has not been recognised in the Australian collections.

The characters of the genus *Selidopogon* are unknown to me.

Genus CHRYSOPOGON Roder. (Text-fig. 4).

Type, *C. crabroniformis* Roder. Queensland.

Characters.—The antennae have the third joint elongate and about as wide as the preceding joints; the fourth joint is conspicuous. There are a pair of strong thoracic spines, one placed on each side of the thorax a little above the wings. The anterior tibiae contain an apical spur.

Genus OPSEOSTLENGIS White. (Text-figs. 1-3).

Type, *O. insignis* White. Western Australia.

Characters.—The antennae have the third joint short, compressed, broader than the preceding ones and contain a strongly developed apical spine which represents the fifth joint. There is a pair of strong thoracic spines, one placed on each side of the thorax a little above the wings. The anterior tibiae contain an apical spur.

Notes.—The face is not concave as stated by White, but normal and similar to the faces of species placed in the genus *Chrysopogon*. The moustache is confined to the oral margin and consists of a row of parallel, long and strong bristly hairs placed so close together that they practically touch one another.

These characters are described from the holotype of the typical species from which also the Text-figures were drawn.

Genus PHELLUS Walker. (Text-fig. 5).

Type, *P. glaucus* Walker. Western Australia.

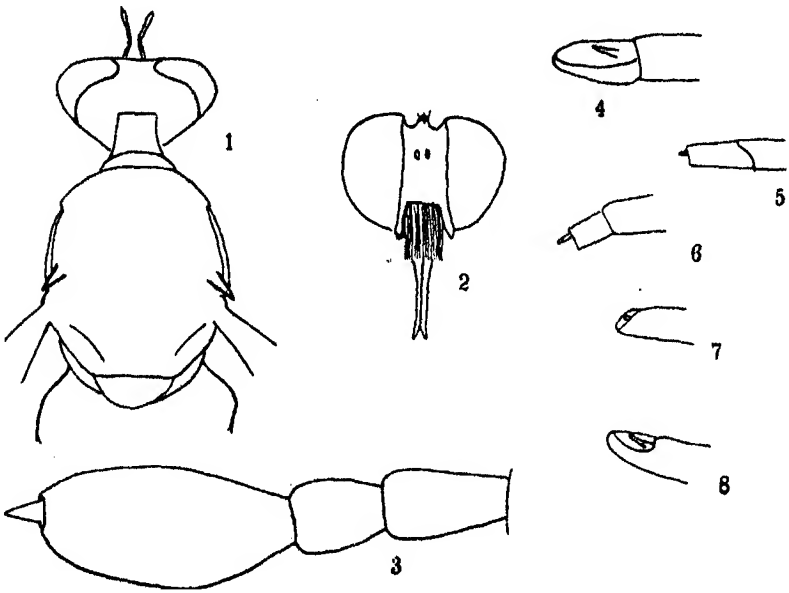
Characters.—The third joint of the antennae is cylindrical and as slender as the basal joints; the fourth joint is long. The anterior tibiae are without a spur. The wings have the fourth posterior cell closed considerably before the wing margin.

Note.—The genus *Phellus* is represented in Australia by one described species and a second, undescribed, which differs in the absence of the prolongation of the intermediate tibiae. In the Australian Museum each form is represented by a female; in the Macleay Museum there are two males of the undescribed species and a pair of *P. glaucus* Walker. The males contain abundant yellow hair on the abdomen and are very dissimilar in appearance to the females.

Genus PSILOZONA Ricardo.

Type, *P. albitarsis* Ricardo. Queensland.

Characters.—The antennae have a conspicuous fourth joint. The anterior tibiae are without a spur. The wings have the fourth posterior cell closed considerably before the wing margin.



Text-figs. 1-3. *Opseostlengis insignis* White, holotype. 1. Thorax; 2. Head seen anteriorly; 3. Antennae seen laterally.

Text-figs. 4-8. The apices of the antennae in various genera of the *Dasypogoninae* 4. *Chrysopogon*, showing the fourth and the fifth spine-like joints; 5. *Phellus*; 6. *Saropogon*; 7. *Neocyrtopogon*, showing the absence of the fourth joint and the minute fifth in the apical depression of the third; 8. *Codula*, showing the fifth spine-like joint in an incision on the dorsal side at the apex of the third.

Note.—These characters are deduced from Miss Ricardo's descriptions and they conform to those of the genus *Phellus*, but, however, *Psilozona* differs in having the sexes similar in appearance.

Genus BATHYPOGON Loew.

Type, *B. asiliformis* Loew (= *aoris* Walker). Australia.

Characters.—The antennae have the fourth joint absent; the first joint is longer than the second. The anterior tibiae are without a spur. The wings have the fourth posterior cell closed considerably before the wing margin.

Notes.—Seven supposedly distinct species are recorded under this genus and the species so far examined cannot be adequately identified by the published descriptions which are based chiefly upon minor colour characters.

Genus DEROMYIA Phillipi.

Type, *D. gracilis* Phillipi. Chile.

Characters.—The antennae are without the fourth joint. The anterior tibiae contain an apical spur. The wings have the fourth posterior cell closed considerably before the wing margin.

Genus ERYTHROPOGON White.

Type, *E. ichneumoniformis* White (= *maculinevris* Macquart). Tasmania.

Characters.—The antennae have the fourth joint apparently present but, owing to the short bristly vestiture with which the apex is covered, the division between the third and fourth joints is not distinct. The anterior tibiae contain an apical spur. The wings have the fourth posterior cell open. The abdomen is club-shaped.

ERYTHROPOGON MACULINEVRIS Macquart.

Dasypogon maculinevris, Macquart, Dipt. Exot., suppl. 4, 1850, p. 65, Pl. vi., fig. 8.—*Brachyrrhopala maculinevris*, Roder, Wien. Ent. Zeit., ii., 1883, p. 273.—*B. maculinervis*, Roder, Stett. Ent. Zeit., liii., 1892, p. 242.—*Erythropogon ichneumoniformis*, White, Proc. Roy. Soc. Tasm., 1913, p. 270; *Id.*, 1916, p. 159, text-fig. 26.

Synonymy.—Miss Ricardo placed *Dasypogon maculinevris* Macquart as a synonym of *Brachyrrhopala limbipennis* Macquart, notwithstanding the fact that Roder had already published a revised description of the species for which he claimed very distinct characters.

Roder's description conforms very well with White's species and, moreover, Macquart's description and figure agree with this species better than with *B. limbipennis*.

Hab.—Tasmania: Hobart, 28th March, 1915; Mt. Maria, 7th February, 1918.

Genus SAROPOGON Loew. (Text-fig. 6).

Type, *Dasypogon luctuosus* Meigen. Europe.

Characters.—The antennae have the fourth joint present. The anterior tibiae contain an apical spur. The wings have the fourth posterior cell open.

Note.—Under the species *Saropogon sergius* Walker, Miss Ricardo states that "From the description of *Dasypogon nitidus* Macquart, from Tasmania, it is possibly the same species as this" and yet in the same work she had previously placed this species under the genus *Brachyrrhopala.*

This discrepancy has been allowed to stand unchallenged in all subsequent references and *Dasypogon nitidus* Macquart has remained in the genus *Brachyrrhopala* where it does not belong.

The generic position of the species is undoubtedly nearer to the genera *Saropogon* and apparently it is not identical with *S. sergius* Walker.

Genus NEODIOCTRIA Ricardo.

Type, *N. australis* Ricardo. New South Wales.

Characters.—The antennae have the fourth joint present. The anterior tibiae are without a spur. The wings have the fourth posterior cell open.

Genus STENOPOGON Loew.

Type, *Asilus sabaudus* Fabricius. Europe.

Characters.—The antennae have the fourth joint present. The anterior tibiae are without a spur. The wings have the fourth posterior cell open.

Note.—The above characters conform to those given under the genus *Neodioctria*, but both the genera have their own very characteristic appearance. Moreover, the Australian species of this genus differ from all the others in having globular male genitalia.

Genus CRYPTOPOGON White.

Type, *C. vernaculus* White. New South Wales.

Characters.—The antennae have the fourth joint present. The anterior tibiae are without a spur. The wings have the fourth posterior cell open. There is an extra cross vein situated between the upper branch of the cubital fork and the radial vein; the presence of this vein separates this genus from all the others.

Genus NEOSAROPOGON Ricardo.

Type, *Dasypogon princeps* Macquart. New South Wales.

Characters.—The antennae are without the fourth joint. The anterior tibiae contain an apical spur. The wings have the fourth posterior cell open.

Note.—The genus differs from *Brachyrrhopala* by the abdomen not being club-form; and from *Neocyrtopogon* by the face not being very convex.

Genus NEOCYRTOPOGON Ricardo. (Text-fig. 7.)

Type, *N. bifasciatus* Ricardo. Queensland.

Characters.—The antennae are without the fourth joint. The anterior tibiae contain an apical spur. The wings have the fourth posterior cell open.

Notes.—The very convex face is the only character published that distinguishes this species from its allies.

In the Macleay Museum there is a species belonging to this genus that has a conspicuously club-form abdomen; the typical species and also others examined have the abdomen normal in shape.

Genus CABASA Walker.

Type, *C. rufithorax* Walker (= *pulchella* Macquart). Tasmania.

Characters.—The antennae are without the fourth joint. The anterior tibiae contain an apical spur. The wings have the fourth posterior cell open.

Note.—There does not appear to be any reliable character to separate this genus, which contains one described species, from *Brachyrrhopala*. The species belonging to the genus never have the hard integuments and the compact knob

of the abdominal club, like those species belonging to the genus *Brachyrrhopala* and, indeed, only some have the abdomen at all resembling a club.

Genus BRACHYRRHOPALA Macquart.

Type, *B. ruficornis* Macquart. Tasmania.

Characters.—The antennae are without the fourth joint. The anterior tibiae contain an apical spur. The wings have the fourth posterior cell open. The abdomen is conspicuously club-shaped, containing a restricted basal portion and a compact apical portion rounded at the apex. The integuments of the abdomen are hard and do not shrivel or collapse when dried, as they do in species of *Cabasa* which have a club-shaped abdomen.

Notes.—The species hitherto known as *Brachyrrhopala nitidus* Macquart, does not belong to this genus; it is allied to the genera *Saropogon*.

The species hitherto known as *Brachyrrhopala limbipennis* Macquart also does not belong to this genus; it is nearer to the genus *Erythropogon*, but differs considerably in the antennae and may represent a new genus.

Genus CODULA Macquart. (Text-fig. 8).

Type, *C. limbipennis* Macquart. New South Wales.

Characters.—The antennae are without the fourth joint. The anterior tibiae are without a spur. The wings have the fourth posterior cell open. The abdomen is club-form.

Subfamily ASILINAE.

Notes.—A paper by White was published in 1917 and in it the Australian genera of the subfamily were given a better taxonomic treatment than that given by Miss Ricardo. The one outstanding feature of White's paper was the elimination of various genera that do not occur in Australia. There are, however, characters taken to be of generic value that do not conform to all the species within the various genera included in White's key.

In the first key given below the genera are grouped into sections according to what is taken to be their primary characters. One of these sections contains three genera that appear to be closely related, although they diverge widely in appearance. Remarks concerning them will be found under their respective descriptions.

The second key can be utilised for the purpose of placing any species into its genus and will be found very easy to use.

For convenience, the more obscure divisions are treated here as subgenera. On this account the names *Neoaratus, Trichoitamus* and *Rhabdotoitamus* do not appear in the keys, but a few remarks upon them will be found under the genera to which they are respectively referred.

Key to the genera of the Asilinae *showing supposed affinities.*

1. Wings with three submarginal cells .. .. *Promachus*
   Wings with two submarginal cells 2
2. Female abdomen with the apical segment cylindrical and in no way different from the others 3
   Female abdomen with the apical segment black, shining, bare of tomentum and more or less compressed .. .. *Blepharotes; Pararatus; Neoitamus*
3. Antennae with the arista bare .. .. *Asilus*
   Antennae with the arista pectinate .. .. *Ommatius*

Alternative key to the genera of the Asilinae.

1. Antennae with the arista pectinate .. .. *Ommatius*
   Antennae with the arista bare 2
2. Wings with three submarginal cells .. .. *Promachus*
   Wings with two submarginal cells 3
3. Abdomen very depressed and broad, and with lateral tufts of hair .. *Blepharotes*
   Abdomen cylindrical 4
4. Female with the apical abdominal segment or segments bare of tomentum, shining and usually strongly compressed 5
   Female with the apical abdominal segment never bare or compressed, always cylindrical and covered with hair and tomentum similar to that on the other abdominal segments .. .. *Asilus*
5. A large black species with a yellow abdomen .. .. *Pararatus*
   Small grey, black or brown species .. .. *Neoitamus*

The genera *Philodicus, Proctacanthus* and *Erax* have not been recognised in the collections examined.

Genus Promachus Loew.

Type, *Asilus maculatus* Fabricius. Europe.

Characters.—The wings have the cubital vein branching before it reaches the radial vein. These branches run parallel and close together for a considerable distance but diverge widely before reaching the margin of the wing. There is a cross vein dividing the area enclosed by the cubital fork at about three-fifths its length, making in all three submarginal cells.

Genus Blepharotes Westwood. (Text-figs. 9-12).

Type, *B. abdominalis* Westwood (= *splendidissima* Wiedemann). New South Wales.

Characters.—The abdomen is depressed, very broad and contains tufts of hairs along the whole length of its lateral borders. The apical segment of the female abdomen is more or less compressed, bare of tomentum and shining black. The wings have the normal two submarginal cells.

Notes.—Under the name *Blepharotes corarius* Wiedemann, a number of species have been confused. They all have a similar colour, but they differ remarkably in the characters of the male genitalia, and to a limited extent in the proportions of the antennae and in markings. Miss Ricardo described a species with a yellow abdomen under the name *B. flavus*, and probably the series of specimens recorded by her under this name also contains more than one species.

The four drawings given here represent the male genitalia of a few of the specimens and two of these, in which the sexes have been taken *in copula*, are described as new, as they probably do not conform to the typical species described by Wiedemann.

The other species described from Australia is *B. vivax* Hermann and is represented by two females in my collection; besides the bright thorax this species also has a differently shaped abdomen.

B. aterrima Hermann from New Guinea, the only species described outside Australia, is unknown to me.

BLEPHAROTES PUNCTATUS, n. sp. (Text-fig. 10).

Description.—This species is one of a series that previously has been confused with *B. corarius* Wiedemann. The antennae have the style as long as the third joint. The thorax contains a pair of white tomentose spots at the apices of the transverse suture. The genitalia of the male conform to Text-figure 10.

The head is brownish and more or less covered—the face is completely covered—with a yellowish white tomentum; the hair on the front is black; the moustache and beard are of the same colour as the face. The eyes, proboscis, palpi and the hairs on the latter are black. There is a row of black bristles behind the eyes. The antennae have the first joint a little longer than the second and the third joint is one and a half times the length of the basal joints united; the style is as long as the third joint.

The ground colour of the thorax is brown and the scutellum is similarly coloured. There is some white tomentum at the sides of the thorax and there are also two pairs of white tomentose spots, one situated at the apices of the transverse suture and the second just above the scutellum. All the bristles and the hairs are black.

The abdomen is yellowish-red and contains a pair of black lateral tufts of long hair on each segment. The third to eighth segments have a few white hairs on the anterior side of each tuft.

The male genitalia are large, black, abundantly covered with long bristly hairs and are of the form shown in Text-figure 10. The upper forceps have a small process on the upper edge, and the apex is broadly truncate; the lower forceps are simple, and contain the apical emargination which is usually present.

The female ovipositor is shining black and is considerably compressed but, however, it contains a dorsal and ventral surface.

The hairs on the anterior and intermediate coxae are white; the legs are entirely black and, with the exception of the above, they have all the hairs and bristles black; the pulvilli are brown.

The wings are uniformly suffused dark brown.

Length.—The male is 33 mm. and the female 35 mm.

Hab.—Queensland; Jandowae, December, 1920 (collected by R. Illidge); one pair taken *in copula.*

Types.—The male holotype and the female allotype are in my own collection.

BLEPHAROTES BRISBANENSIS, n. sp. (Text-fig. 9).

Description.—This species is one of a series that has previously been confused with *B. corarius* Wiedemann. The antennae have the style only a quarter the length of the third joint. The male genitalia are as shown in Text-figure 9.

The head is black and has some white pubescence on the front; the tomentum on the face is light yellowish and the moustache and beard are of the same colour. The eyes, proboscis, palpi and the hairs on the latter are black. There is a row of black bristles behind the eyes.

The antennae have the first joint a little longer than the second and the third two and a half times the length of the first and second together; the style is a quarter the length of the third joint.

The ground colour of the thorax is black and there is some white lateral tomentum.

The abdomen is yellowish red and on each segment there is a pair of black lateral tufts of hair. The third to eighth segments have a few white hairs on the anterior side of each tuft.

The male genitalia are large, black, abundantly covered with black bristly hairs and are of the form shown in Text-figure 9. The upper forceps have a blunt process on the upper edge and the apex is pointed. The lower forceps are simple.

The female ovipositor is black, shining and considerably compressed.

The hairs on the anterior and intermediate coxae are white. The legs are entirely black and, with the exception of the above, they have all the hairs and bristles black; the pulvilli are brown.

The wings are uniformly suffused dark brown.

Length.—34 mm.

Hab.—Queensland: Mt. Coot-tha, Brisbane, 19th December, 1920. A pair taken *in copula.*

Types.—The male holotype and the female allotype are in my collection.

Genus PARARATUS Ricardo.

Type, *Blepharotes macrostylus* Loew. Western Australia.

Characters.—The abdomen is cylindrical and the female has the apical segments more or less compressed, similar to the compressed abdomens of some species of the genus *Neoitamus* but the lamella appears to be differently constructed. This lamella seems to be composed of three separate plates, one lying horizontally and the other two placed above it in such a manner that the apical borders of the three plates form a triangle. The lamella widens towards the apex. The wings have the normal two submarginal cells.

Genus NEOITAMUS Osten-Sacken.

Type, *Asilus cyaneus* Loew. Europe.

Characters.—The abdomen is cylindrical. The female has the apical segments more or less compressed and the lamella is apparently simple. In one species retained within this genus there are apparently two small separated lamellae on the female abdomen. The wings have the normal two submarginal cells.

Note.—The genera *Rhabdotoitamus* and *Trichoitamus* were described by White on characters of insufficient importance to warrant them being accepted as of generic rank. Too little is yet known about this obscure group to form satisfactory definitions or even to suggest any difference between the genera proposed by White.

NEOITAMUS ABDITUS White.

Hab.—New South Wales: Grenfell, April 1921; collected by Miss E. C. Horrocks. This record adds a new State to the range of this species.

NEOITAMUS NEOCLARIPES, n. sp.

Neoitamus claripes, Hardy (*nec* White), Proc. Linn. Soc. N.S. Wales, xlv., 1920, p. 197, Text-fig. 11.

Synonymy.—I am indebted to Major E. E. Austen who has kindly compared my figures of the genitalia in These Proceedings (Vol. xlv.) with some of the type specimens of the genera *Asilus* and *Neoitamus* in the British Museum.

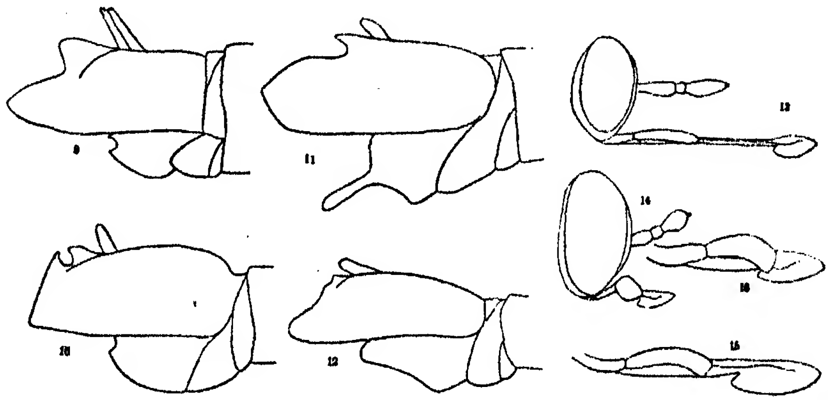
Of this species Major Austen writes.—"The forceps in the type are much less elongate than they appear in figure 11; they are not attenuated towards the distal extremity as in the figure."

Evidently my identification of White's species is incorrect and it is necessary to give a new name to the species I previously described under White's name.

Genus Asilus Linnaeus.

Type, *Asilus crabroniformis* Linnaeus. Europe.

Characters.—The abdomen is cylindrical and in the female the apical segments do not differ in any respect from the basal segments. The wings have the normal venation with two submarginal cells.



Text-figs. 9-12. The male genitalia of various species belonging to the genus *Blepharotes*. 9. *B. punctatus*, n. sp.; 10. *B. brisbanensis*, n. sp.; 11. A species from Perth, Western Australia, which has a yellow abdomen, and an apicalprocess on the lower forceps; 12. A species from Perth with a yellowish-red abdomen and comparatively small genitalia unique in having no prominent characters.

Text-figs. 13-16. Parts of the head of various species belonging to the genus *Apiocera*. 13. Head of a male specimen from Perth, Western Australia, which specimen has very long antennae, palpi and proboscis; 14. The head of a male from Sydney in which the head appendages are short; 15. The palpi and proboscis of a species from Perth which has the colour pattern of *A. moerens*, as illustrated by Westwood: 16. The palpi and proboscis of a male specimen from Sydney.

Note.—The subgenus *Neoaratus* is formed for a species that differs from the others by having part of the costa produced forward.

Genus Ommatius Wiedemann.

Type, *Asilus marginellus* Fabricius. North America.

Characters.—The antennae have the arista pectinate and in this respect the genus differs from all the others. The abdomen has the apical segments similar to the basal ones. The wings have the normal venation with two submarginal cells.

Family APIOCERIDAE.

Historical.—In 1830, Wiedemann described *Laphria brevicornis*. In 1838 (pt. 2, p. 78) Macquart proposed the genus *Tapinocera* for Wiedemann's species without seeing it, and he retained the genus within the family *Asilidae*. Later, in 1847, Macquart described and illustrated *Pomacera bigotii* from Tasmania and did not recognise his genus *Tapinocera* in the species.

Westwood described *Apiocera fuscicollis* and *Apiocera asilica* in 1835; in 1841 he added *A. moerens* and at the same time made the statement that he was not satisfied with the specific diversity of the three species. He also mentioned that his specimen of *A. asilica* was in a very mutilated state.

In 1854, Walker placed *P. bigotii* Macquart as a synonym of *A. asilica* Westwood but, however, as the description given by Walker was that of *A. moerens* and not that of *A. asilica*, it is possible that Walker intended to make Macquart's species a synonym of *A. moerens* Westwood.

In 1883, Osten-Sacken published remarks similar to the above and expressed the opinion that the whole subject required a revision based upon abundant material and added that the genus was represented by four different species which he had seen in collections.

In 1909, Hermann recorded a female of *A. moerens* Westwood from North Borneo and a male from New South Wales; also a male of *A. fuscicornis* Westwood from New South Wales and a female of *A. bigotii* Macquart from Cooktown, Queensland; finally he described a species from Queensland under the name *A. vulpes*.

It is to be regretted that Hermann did not improve upon the descriptions of *A. bigotii* Macquart, *A. fuscicollis* Westwood and *A. moerens* Westwood from the material he had at his disposal as this would have been more useful than adding a new name to the uncertain number of valid species previously described.

Genus Apiocera Westwood. (Text-figs. 13-16).

Type, *A. fuscicollis* Westwood. Australia.

Characters.—Rather large thick-set flies with three-jointed antennae and a one- or indistinctly two-jointed style. The wings have a complex venation. The costal and subcostal veins meet before the apex of the wing; the mediastinal vein between them reaches to or beyond half the length of the wing. The radial vein runs into the subcostal. The upper and lower branch of the cubital vein runs into the wing margin before the wing apex. The first posterior vein runs to the margin at about the apex of the wing. The second posterior vein runs about parallel to the first but reaches the wing margin considerably after the apex. The third posterior vein meets the fourth, thus closing the fourth posterior cell, before reaching the wing margin. The fifth posterior vein meets the anal at or about the wing margin. The anal vein is slightly sinuous.

The exoskeleton shows differences of specific value in the characters discussed below.

Head: Considerable structural differences are to be found between the species in the proportional length, size and shape of the palpi which are two jointed; in the length of the proboscis; and in the proportional shape and length of the antennae. Text-figures 13 to 16 represent four distinct species that differ widely in these respects.

Genitalia: The genital organs do not show many external characters of specific value. The species usually have simple upper and lower forceps in the males, but one species has the upper forceps of the male genitalia bent downwards considerably at the apex. The females all bear the same number of spines at the apex of the abdomen.

Colour and colour pattern: The colour of species forms a very inadequate determining factor but there are a few outstanding species that differ in this respect from the rest. Also a few species appear to have a unique colour pattern.

Notes.—The above revision of this genus is included in this paper for the purpose of showing that certain characters are of specific value, and it is to be hoped that the remarks may be found useful when the type specimens, all of which are in Europe, are examined. The revision is based upon abundant material, as Osten-Sacken suggested should be done, but without the types it is impossible to carry this revision beyond the point here attained.

Family THEREVIDAE.

Notes.—In the "Thereviden der Indo-Australischen Region" Krober (1912) has left the taxonomy of the genera, as far as Australia is concerned, in a condition that cannot be considered satisfactory.

In 1915, White revised the *Therevidae* of Tasmania, and pointed out that in classifying the genera the form of the venation of the wing seemed to him to be of great importance.

An independent investigation into a large number of species of *Therevidae* of Australia, including most of the known genera, has led me to the same conclusion as that arrived at by White and, therefore, it is certain that the venation will provide some characters of importance for the proper grouping of the Australian genera.

It is proposed here to divide the Australian *Therevidae* into two groups based upon the open and closed fourth posterior cells, a character sometimes ignored in Krober's work.

Group 1, containing species with the fourth posterior cell open, includes the genera *Belonalys, Taenogera, Ectinorrhynchus, Anabarrhynchus, Platycarenum,* and *Psilocephala.*

Group 2, containing species with the fourth posterior cell closed, includes the genera *Agapophytus, Phycus, Acatopygia, Acupalpa, Lonchorhynchus, Odenbergia, Parapsilocephala, Pseudoloxocera, Acraspisa* and *Clesthentia.*

The genera *Spatulipalpa* and *Eupsilocephala* have not been recognised in the collections examined, and from their descriptions the first contains species with the fourth posterior cell closed and open, and in the second the character is ignored.

Genus BELONALYS Krober.

Type, *B. obscura* Krober. New South Wales.

Note.—A primary character given by Krober and upon which he has founded the genus will be found at the base of the discal cell. The two veins which border this cell anteriorly and posteriorly radiate from a point, so that the base of the discal cell forms an acute angle. A species of this genus, which is represented by two specimens before me, shows that in one specimen the wing character agrees with the above description, but in the other the venation is more

or less normal and therefore this wing-character cannot be considered of generic value.

PHYCUS ?? BASIPUNCTATUS Walker.

Xylophagus basipunctatus, Walker, Trans. Ent. Soc. Lond., iv., 1857, p. 121.—*Erinna basipunctata,* Kertesz, Cat. Dipt., iii., 1908, p. 135.

Affinities.—This outstanding description evidently belongs to the *Therevidae.* The antennae are described as having the second joint very short, the third lanceolate and shorter than the first; these characters suggest the genus *Phycus.*

The species has not been recognised in the collections and Kertesz left the reference in the family *Erinnidae* under the genus *Erinna* which equals the genus *Xylophagus* of other authors.

Genus PLATYCARENUM Krober.

Type, *P. porrectifrons* Krober (= *quinquevittata* Macquart). Cape York.

Note.—The produced head of the species placed in this genus will distinguish it from those in the genus *Anabarrhynchus.*

PLATYCARENUM QUINQUEVITTATA Macquart.

Thereva quinquevittata Macquart, Dipt. Exot., suppl. 2, 1847, p. 50.—*Thereva arida* Walker, Trans. Ent. Soc. Lond., iv., 1857, p. 133.—*Platycarenum porrectifrons* Krober, Ent. Mitt., i., 1912, p. 244 (Text-fig.)—*Anabarrhynchus pallidus* White, Proc. Roy. Soc. Tasm., 1915, p. 39 (Text-fig. 21).

Synonymy.—The above descriptions undoubtedly belong to the same species which is widely distributed on the eastern coast of Australia and which frequents sand-dunes.

Note.—White's figure does not resemble the shape of the head and antennae in the least. The black spots on the front vary considerably in size and shape.

Hab.—Tasmania, New South Wales and Queensland.

ANABARRHYNCHUS RUFIPES Macquart.

Anabarrhynchus rufipes, Macquart, Dipt. Exot., suppl, 4, 1850, p. 99, pl. ix., fig. 11; White, Proc. Roy. Soc. Tasm., 1915, p. 47; Hardy, Proc. Roy. Soc. Tasm., 1916, p. 207.—*A. terrenus* var., White, Proc. Roy. Soc. Tasm., 1915, p. 45.

Synonymy.—As suggested by White, his coastal variety of *A. terrenus* is not identical with the typical form from the bushlands. From series collected on coastal sand-dunes at Bellerive, near Hobart, it is found that there are grades between the typical species of *A. rufipes,* as identified by myself, and the variation described by White under *A. terrenus.*

ANABARRHYNCHUS TERRENUS White.

Anabarrhynchus terrenus, White (exclusive of variety), Proc. Roy. Soc. Tasm., 1915, p. 45.

Synonymy.—As already stated above, the typical form of this species which occurs in the bush lands is distinct from the species included under this name as a variety. This second species is referred to *A. rufipes* Macquart, and it seems probable that the first, which is the typical species, was previously described by Macquart (1846, p. 104) under the name *Thereva hyalipennis.*

Genus CLESTHENTIA White.

Type, *C. aberrans* White. Tasmania.

Affinities.—This genus was originally placed in the family *Leptidae* (White, 1914) and was retained in this family by me in 1919. It is here proposed to transpose the genus to the *Therevidae* on account of its possessing the following characters:—

1. The presence of some more or less distinct thoracic bristles situated laterally and similar to those on other species of *Therevidae.*
2. A closed fourth posterior cell.
3. The absence of a pulvilliform empodium.

All these characters are contrary to those of the family *Leptidae.* A re-examination of the supposed tibial spurs shows them to be apical spines similar to those in other genera of the *Therevidae.*

Family DOLICHOPODIDAE.

ARACHNOMYIA CUPREUS Macquart.

Hydrophorus cupreus, Macquart, Dipt. Exot., suppl. 4, 1849, p. 123, Pl. xii., fig. 2; White, Proc. Roy. Soc. Tasm., 1916, p. 258.—*Arachnomyia arborum,* White, Proc. Roy. Soc. Tasm., 1916, p. 253, text-fig. 50.

Synonymy.—The description of *Hydrophorus cupreus* Macquart agrees in every respect with specimens of *Arachnomyia arborum* White, so undoubtedly Macquart's species will be found identical with White's when the type is examined; both were described from Tasmania where this species is abundant. Moreover, I believe the genus *Hydrophorus* does not occur in Australia; not only have I searched for it in Tasmania, New South Wales and Queensland without success, but also it is not represented in any collection I have seen.

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——— 1846.— „ „ Supp. i.

——— 1847.— „ „ Supp. ii.

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AUSTRALIAN *COLEOPTERA*: NOTES AND NEW SPECIES.

By H. J. Carter, B.A., F.E.S.

This paper originated in the examination of material lately acquired for the Queensland Museum by Mr. Henry Hacker, the very efficient entomologist of that Institution. It also includes notes and descriptions of Mr. H. W. Brown's captures in the Northern Territory, descriptions of two new *Lucanidae* from that prolific district, the Barrington or Mount Royal Range, together with notes on synonymy gleaned from my correspondence with Mr. K. G. Blair of the British Museum.

LUCANIDAE.

Rhyssonotus politus, n. sp. (Text-figs. 1, 2.).

Oval, bronze (with a reddish tinge), very nitid, glabrous above, a short fringe of yellow hairs on anterior coxae, also at apex of abdomen and prosternum, legs and tarsi reddish.

♂. *Head* 2½ x 6 mm.—excluding mandibles—rugose-punctate, forehead with medial saddle-shaped ridge, bituberculate in front, sides of head widely lobate, the lobe rounded in front, angulate behind; mandibles projecting about 3 mm., each armed with 5 or 6 tuberculiform teeth on inside and a single conical tubercle near external edge towards the base; upper surface of mandibles coarsely rugose, underside lightly punctate; mentum arched and projecting; eyes completely divided, antennae with scape longer than other joints combined, club 6-jointed.

Prothorax 6 x 9 mm., considerably wider than the elytra at base, anterior angles rounded and convex, sides lightly arched, a small sinuation preceding the sub-posterior tooth, this followed by oblique arcuate excision to the true base; narrowly bordered throughout, lateral border entire or, sometimes, feebly crenulated by an irregular row of setiferous punctures. Surface mirror-like, sparsely and finely punctate, the punctures almost evanescent at middle, larger at sides, with a strong medial groove, two small foveae near middle of each lobe and a depressed area at sides.

Scutellum transversely oval, its border raised.

Elytra about as long as wide (9 mm.), sides a little explanate, scarcely wrinkled, with a row of large punctures forming inner boundary of margin; the edge of suture carinate, and two obsolescent ridges perceptible on basal area, one parallel to suture, the other oblique; surface mirror-like with some sparse, minute punctures to be seen with a lens. Flanks of prosternum sparsely and finely punctate and setiferous, abdomen more coarsely punctate, the two last

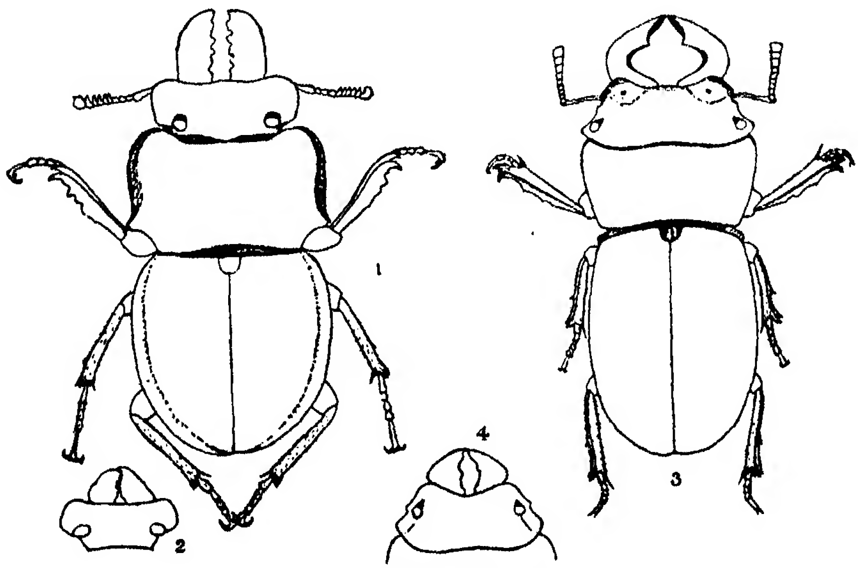
segments densely so and terminated by a fringe of golden hair; protibiae 4-dentate externally, bidentate internally, hind tibiae with 3 strong spines at apex, profemora with wide excision on inside edge near apex.

♀ with shorter mandibles (about 2 mm.); these rugose-punctate above, with two small tubercles on outside edge near base; the pronotum coarsely punctate, especially near sides (in marked contrast to the puncturation of ♂).

Dimensions. ♂. 19-23 x 8-10 mm. ♀. 17-23 x 8-11 mm.

Hab.—New South Wales: Mount Royal or Barrington Tablelands. (Mr. John Hopson).

Eight examples examined, 5 ♂, 3 ♀, taken by Mr. Hopson. It is allied to *R. jugularis* Westw., but differs from that species in its extremely nitid and lightly punctate surface, the structure of head and mandibles, the narrower and



Text-fig. 1. *Rhyssonotus politus*, n.sp. ♂.
,, 2. ,, ,, Head of ♀.
,, 3. *Lissapterus hopsoni*, n.sp. ♂.
,, 4. ,, ,, Head of ♀.

smoother elytral margins *inter alia*. *R. laticeps* Macl. is still closer in colour and facies, but has striate-punctate elytra with sharp wing-shaped lateral projections to the head. Types in Coll. Carter.

LISSAPTERUS HOPSONI, n. sp. (Text-figs. 3, 4.)

Black, moderately nitid, legs and tarsi clad with golden hairs.

♂. *Head* wide and convex, sides bilobed, the anterior lobe somewhat squarely explanate, the carinate border of the eye terminating anteriorly in a small tubercle, the posterior lobe forming a blunt tooth pointing outwards, a small tooth also on sides between anterior and posterior lobes; surface coarsely punctate at sides, becoming smooth at middle and apex; mandibles (projecting about 3 mm.)

outwardly curved at base, then obliquely inwards, the acute tips meeting; a wide tooth on inside of each near apex, the inferior basal area flattened into a lamina projecting downwards; antennae with three apical joints wider than rest —these successively widening to apex—the two penultimate feebly dentate on anterior side; the mandibles finely and sparsely punctate.

Prothorax twice as wide as long, sides lightly narrowing from apex to base, front angles semicircularly rounded, posterior widely obtuse, disc coarsely punctate, confluently at base and sides, nearly smooth at middle, medial channel indicated near front; a few irregular depressed areas on disc. *Scutellum* semicircular, nitid, with a few large punctures. *Elytra* of same width as prothorax at base, feebly widening towards middle, narrowly margined, surface closely and strongly punctate, except on three laevigate vittae; the first of these sutural, the other two meeting on apical declivity, slightly diverging towards and continuous to base, the third near the middle of elytron; beyond this one or two finer laevigate lines perceptible. Tibiae bidentate exteriorly and spinose internally at apex, fore-tibiae with about three teeth, the others with one on outside edge, claws very slender; underside coarsely punctate on sternal areas, abdomen smooth.

♀. Mandibles short—projecting about 1½ mm.—stout and coarsely punctate, without any defined internal tooth; prothorax with more clearly defined medial line.

Dimensions (including mandibles). ♂. 20 x 8 mm. ♀. 21 x 9 mm.

Hab.—New South Wales: Eccleston, Allyn River. (Mr. John Hopson).

Another of Mr. Hopson's discoveries in the hills adjoining the Barrington plateau, and I name the species in his honour. Smaller than its allies, it is clearly differentiated by the peculiar elytral sculpture, with its defined laevigate vittae. *L. tetrops* Lea has a somewhat similar—though far more obscure—arrangement, the smooth areas being bounded by single lines of minute punctures.

Type in Coll. Carter.

BUPRESTIDAE.

In the table of *Cyphogastra* given by the late Mons. Kerremans ("Monographie des Buprestides," T. iv., p. 163) *C. pistor* C. and G. is distinguished from *C. saundersi* Macl. as follows:—

"Elytres bordés extérieurement d'un large sillon prémarginal, allant de l'épaule au sommet . . . . *pistor*.

Impression latérale de l'elytre n'atteignant pas le sommet . . . . . . *saundersi*.

This distinction, however, is not only contradicted by the original description of *C. pistor* by Castelnau and Gory, fully corroborated by the coloured figure in the excellent monograph of those authors, but it is inconsistent with the detailed description of *C. pistor* given by Kerremans himself on p. 179 of the work quoted above, where the lateral impression is thus described "la cinquième" (impression) "enfin, *plus courte,* contre le bord extérieur, *naissant en avant, à la hauteur de la précédente, mais terminée loin du sommet.*" The italics are mine.

I have lately again closely examined the types of *C. saundersi* in the Macleay Museum, and similar examples in the Masters Collection and the Australian Museum (probable cotypes), and must reiterate the opinion I expressed (Trans. Roy. Soc. S. Aust., 1916, p. 139) as to their identity with the correctly determined specimens of *C. pistor* in those collections—the superficial variations being due to abrasion or immersion in spirit.

Cyphogastra vulnerata Théry (Text-fig. 5). Mr. H. W. Brown has lately taken in the Northern Territory a long series of a *Cyphogastra* which *does*, however, agree with Kerremans' tabulated "*pistor*" (?) in having a lateral impression extending from base to apex, while also agreeing with that part of his detailed description of *pistor* (Monograph, p. 179) which states "au lieu de se prolonger en pointe sineuse et relevée, les côtés sont graduellement et régulièrement attenués en arc." This species clearly corresponds with the description of *C. vulnerata* Théry, a species hitherto unknown in Australian collections and erroneously placed by Kerremans as a synonym of *C. pistor* C. and G., from which it is clearly separated by (1) more convex and oval form, (2) angulately widened prothorax, sides nearly straight behind, (3) arrangement and form of elytral impressions. (Besides the difference in the lateral impression noted above, the premedial discal impression is longer, while the posterior discal impressions diverge from the suture, and are not parallel with it, as in *pistor*). The 7 Australian species of *Cyphogastra* readily arrange themselves into 3 groups.

A. containing *C. pistor* C. and G., *C. vulnerata* Théry, and *C. browni*, n. sp.

B. „ *C. macfarlani* Waterh., *C. venerea* Thoms. and *C. farinosa* F. (the last described as from Java, doubtfully Australian).

C. containing *C. woodlarkiana* Montr. (of which the upper surface is entirely black).

C. venerea is chiefly differentiated from *C. macfarlani* by the absence of the lateral impression on the elytra. *C. farinosa*, besides having certain ground colour difference from *C. macfarlani*, has an extra discal ray on the elytra.

Chrysodema sub-fasciata Cart. Mr. H. W. Brown has taken a long series of this species in the Northern Territory. The two types in the Melbourne Museum were the only examples hitherto known in Australian Collections.

The genera of the tribe *Chalcophorini* are not generally well known to Australian Collectors. I therefore append a tabulation of the six Australian genera so far recorded.

Tribe **Chalcophorini.**

1		Pronotum longitudinally carinate in middle	*Chrysodema* C. and G.
2	8	Pronotum and prosternum longitudinally sulcate in middle.	
3	5	Last abdominal segment carinate in middle.	
4		Form ovate acuminate	*Chalcotaenia* Deyr.
5		Form navicular, 1st abdominal segment having a smooth salient plate at apex	*Cyphogastra* Deyr.
6	8	Last abdominal segment not carinate.	
7		First abdominal segment sulcate in middle	*Chalcophorella* Kerr.
8		First abdominal segment **not** sulcate	*Paracupta* Deyr.
9		Pronotum partially, or not, sulcate, prosternum not sulcate, whole prothorax very rugose	*Pseudotaenia* Kerr.

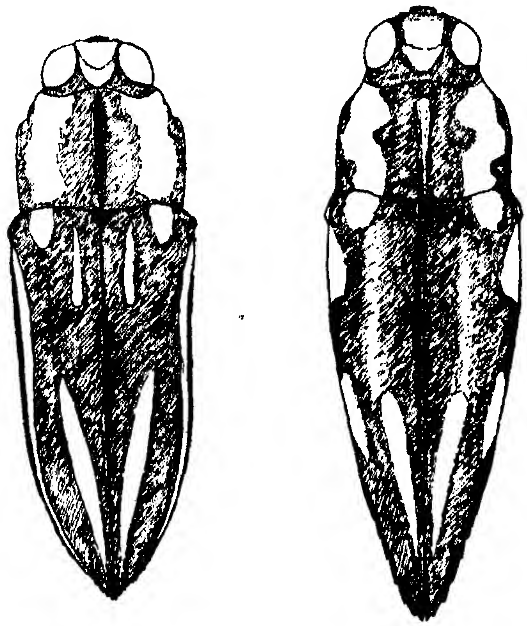
Pseudotaenia contains the giants of the group and *Chalcophorella* the smaller and narrower species.

The 35 Australian species are divided as follows:—*Chalcotaenia*, 11 species; *Cyphogastra*, 7; *Chalcophorella*, 3; *Pseudotaenia*, 8; *Paracupta*, 4; *Chrysodema*, 2. *Chalcotaenia* and *Pseudotaenia* are endemic in Australia or adjacent islands (one species of the former in Papua). *Chalcophorella* occurs also in America, Europe, Africa, and one species in Japan. The remaining three genera have a wide distribution throughout Malaysia and Oceania.

CYPHOGASTRA BROWNI, n. sp. (Text-fig. 6.)

Navicular; upper surface dark green, with impressions filled with yellow flocculence, head bluish; underside metallic green, almost entirely obscured by yellow flocculence; raised medial lobe of abdomen purple, antennae bronze, legs and tarsi metallic green, knees blue.

Head subtriangularly excised on front—the apex of triangle somewhat arched —a large irregular impression filled with yellow flocculence between the eyes, this bordered by crenulate ridge; basal area sparsely rugose-punctate.



Text-fig. 5. *Cyphogastra vulnerata* Théry. Text-fig. 6. *Cyphogastra browni*, n.sp.

Prothorax depressed, bisinuate at apex (strongly) and at base (slightly); all angles acute; widest at base, sides nearly straight and gently narrowing till near the front, then sinuately converging to the angles; disc with wide medial sulcus, a wide, irregular, trilobed, flocculent impression occupying the greater part of sides; the raised parts near centre sparsely punctate—at sides rugose-punctate.

Scutellum metallic green, rather square and depressed in middle.

Elytra slightly wider than prothorax at base, angulately widening at shoulders and tapering to the acuminate apex, terminating in two larger sutural spines—with about 6 strong serrations on each side: each elytron with four flocculent impressions, the first circular at basal margin (about midway between suture and shoulder), the second pear-shaped, larger than first, at sides before the middle—its narrower part produced forward along margin beneath the humeral callus, the third lanceolate, forming a short vitta near suture on posterior third and extending to apex; the fourth short and longitudinal at sides, postmedial (starting slightly in advance of the third); the remaining surface irregularly

punctate, the punctures coarse and rugose on basal area, finer and shallower towards apex; here and there showing a linear arrangement. Prosternum, meso- and metasternum widely sulcate, the convex plate of 1st abdominal segment rounded behind, acuminate in front, sparsely punctate. *Dimensions*: 29 x 9½ mm.

Hab.—Northern Territory. (H. W. Brown).

I gladly name this after the very enterprising collector who has added so many fine new species to the Australian list of Coleoptera.

C. browni can easily be distinguished from *C. pistor* by the absence of the discal pre-medial impression (the "second" of Kerremans' description) and the much abbreviated lateral impression (the "fifth" of Kerremans). Type in Coll. Carter.

STIGMODERA PRAETERMISSA, n. sp.

Oblong oval, head, antennae and prothorax coppery, elytra with margins and costae red, the intervals mostly black, underside and legs blue.

Head widely excavated, finely punctate.

Prothorax subtruncate at apex, strongly bisinuate at base, widest at base, sides arcuately narrowing to apex, surface uneven with four large depressions. A large irregular one on each side, an oval one at middle of base, connected by medial sulcus with a small triangular depression at apex, the areas between depressions tumid, the whole rather closely and coarsely punctate.

Scutellum very concave and punctate.

Elytra each with four well raised costae, the first two only continuous from base to apex, the 4th starting from margin at base, terminating well within the margin towards apex, the 3rd connecting with 4th near base and terminating between the 2nd and 4th; each apex with a minute notch, costae and intervals finely punctate, the latter also finely transversely reticulated; sternum coarsely, abdomen finely and densely punctate, scarcely pilose. *Dimensions*: 10-11 x 4 mm.

Hab.—Blue Mountains, New South Wales. (Dr. E. W. Ferguson and H. J. Carter).

Of the two examples examined, the ♂ taken by myself in 1903 has long been considered as *S. spinolae* C. and G. which it nearly resembles. The ♀ example, lately given me by Dr. Ferguson, has induced me to make a close examination which has revealed clear distinctions from *S. spinolae* in (1) smaller size, (2) underside blue (black in *spinolae*), (3) much finer surface punctures, (4) marked differences in shape and sculpture of prothorax (in *spinolae* the middle depression is cordate, the sides contain rounded projections, concave within, etc.). Types in Coll. Carter.

PARACEPHALA TRANS-SECTA, n. sp.

Sub-cylindric, bronze, sometimes in parts with bluish reflexions, sides of abdomen with pale golden hairs.

Head finely punctate, with wide longitudinal furrow.

Prothorax strongly transverse and convex, widest near front; apex a little produced at middle and at the angles—the latter widely rounded: sides obliquely narrowing to base, posterior angles obtuse, base strongly bisinuate; disc transversely divided near middle by a wide sulcus, expanding on each lobe into a wider depression, not continuous to sides; lateral margins thickly clothed with golden hair, a faint medial sulcus sometimes seen on posterior half of disc; surface finely punctate and transversely strigose.

Elytra of same width as prothorax at base, narrowing from behind shoulders to the apex, each elytron separately rounded behind; margins entire, surface finely rugose-punctate, feebly pilose at sides only; underside finely punctate, each puncture giving rise to a short golden bristle besides the lateral patches of longer hairs. *Dimensions*: 6-7 x 1.6-2 mm.

Hab.—Barossa, South Australia (R. J. Burton) and Mount Tambourine, Queensland (Mr. Relton).

Two examples from Mr. Burton—the types—are rather more robust than a pair lately received from the Relton bequest to the Queensland Museum, but are clearly conspecific. The species can be readily separated from all so far described by the curiously transversely divided prothorax. Types in Coll. Carter.

TENEBRIONIDAE.

Synonymy.

Docalis funerosus Hope = *D. maculatus* Blackb. Mr. Blair has confirmed my suspicion of this by a comparison of the types.

Sobas (*Trigonotarsus*) *australis* Hope. Specimens identical with those taken at Roebuck Bay (W.A.) by Commander J. J. Walker and determined by Mr. G. C. Champion as *Pseudocaedius squamosus* Blackb. are now found, by comparing the types, to be conspecific with *Sobas australis*. Mr. Blair, however, considers that this is not *Ps. squamosus*, of which he has sent me an example (compared with type) that is a little smaller and with fewer and more irregular setae on the upper surface (also from Roebuck Bay). I am unable to make out specific distinctions that cannot be accounted for by individual variation or by abrasion. The synonymy of these two species is thus open to question. The erroneous labelling in our Museums of examples of *Caediomorpha heteromera* King as *Sobas australis* Hope appears to be traceable to the British Museum, where this confusion seems to have been of long standing.

Uloma sanguinipes F. = *Acthosus laticornis* Pasc. ♂ } by comparison
= *U. depressa* Pasc. ♀ } of types.
= *U. consentanea* Perroud (*fide* Gebien's Catalogue).

The genus *Acthosus*, described by Pascoe in 1863 for the reception of *A. westwoodi*, seems to me insufficiently differentiated from *Uloma* (*Vide* These Proc., 1919, p. 145). Gebien has, however, described four new species of *Acthosus* and nine of *Uloma* in the "Resultats de l'Expedition scientifique Néerlandaise à la Nouvelle-Guinée" (1920), thus recognizing their distinction.

Diaclina (*Heterocheira*) *nitida* Cart. = *D. immaculata* Geb. Specimens were sent to the British Museum, of which Mr. Blair writes: "*H. nitida* Cart. is a *Diaclina* (a good genus, not synonymous with *Alphitobius*) very near, if not a form of *D. calliope* Chevr. from Gilolo."

Diaclina Jacq. du Val.—placed by Gebien in the Junk Catalogue as a synonym of *Alphitobius*—thus enters into Australian lists. Gebien has redescribed *D. nitida* under the name *D. immaculata* in his work on Papuan ***Tenebrionidae*** quoted above, a synonymy confirmed by Mr. Blair.

Saragus brunnipes Bois. = *S. macleayi* Blackb. *See* note under *S. ellipsoides* infra.

Dysarchus Pasc. = *Saragodinus* Bates (*fide* Mr. K. G. Blair). The genotypes of these genera are evidently closely allied. Mr. Blair writes "*D. odewahni* Pasc. resembles *howitti* Bates in shape, size, and, to some extent, in sculp-

ture of thorax, but the sides of the latter in *howitti* are entire not granulate; in *odewahni* they are broken by very strong prominent marginal granules. The elytra of the latter have 4 rows of elongate granules (or costae), the interspaces with irregularly disposed sharp granules and short hairs, in *howitti* the interspaces have each a median row of somewhat similar granules, the intermediate space irregularly, not closely punctured. I have only the type of each."

Styrus batesi Haag. (Jour. Mus. Godeffr., p. 117-118 footnote) nom. nov. for *S. elongatulus* Bates.

Saragodinus batesi Haag. *Id.*, p. 117.

These two names appear to have been confused and the latter omitted from Gebien's catalogue. In my "Revision of the Nyctozoilides" (Ann. Queensland Mus., 1911, p. 12) I placed Bates's *Styrus* as a probable synonym of *S. elongatulus* Macl., of which I have cotypes. Of a larger species from Dalveen (Q.), Mr. Blair writes "Your specimen I regard as *S. elongatulus* Bates, with which it agrees in size, colour, sculpture, etc., but from which it differs in the shape of the thorax. The latter in the type has the sides more widely and evenly rounded, as in *latior* . . . . and the posterior angles directed backwards instead of outwards."

Agasthenes goudiei Cart. = *A. euclensis* Cart. On comparing a second example of the former with the type of the latter, I consider that the second name should be sunk, the differences formerly noted being rather individual than specific.

COTULADES TUBERCULATUS, n. sp.

Convex and widely oval; chocolate brown, elytra with pale patches of light fascicles, surface clothed with coarse recumbent hairs.

Head: Epistoma concave in front, forehead rather flat except for a strong depression on each side, sculpture obscured by bristly clothing; antennae very wide, joints strongly transverse and closely fitting; 1st and 3rd longer than the rest, 11th narrower than 10th, oval, the rest subequal.

Prothorax ovate, very convex and uneven; at apex a little wider than head, and produced in middle; base subtruncate, sides lightly rounded, margins a little crenulated—the true crenulations not easily distinguished from the apparent ones caused by the short bristles; disc with four strongly raised protuberances, two, rather close, overhanging anterior margin; two much larger—one at centre of each lobe; the middle part forming a deep, wide oval depression; also a foveate depression near each hind angle; all angles rounded off.

Elytra strongly convex, of same width as prothorax at base, the produced angulate humeri fitting the pronotal foveae; sides thence obliquely widened and forming a second angle at junction with straight portion; abruptly narrowed at apex; each elytron with three interrupted costae, terminating in large tubercles on apical area, a wide sutural area flatter than the rest; sculpture, as on rest of surface, obscured by thick bristly hairs, but a few large, widely set, punctures and some small shining tubercles can be made out; the lateral area, outside the 2nd sub-costa, containing an irregular row of pale fascicles, also a strong bundle of these on apical third, between 1st and 2nd sub-costa. *Dimensions*: $4\frac{3}{4}$ x $2\frac{1}{4}$ mm.

Hab.—Mittagong, N.S. Wales.

I have an example of *C. fascicularis* Pasc. from Tasmania, and five of *C. montanus* Blackb. from the Blue Mountains. *C. tuberculatus* is larger, especially wider, than either of these, with a much more uneven and bristly surface. In *C.*

montanus the coarse, close-set elytral punctures can always be clearly seen, the pronotum is much less uneven, though the elytra have some apical tubercles not mentioned by the author. *C. fascicularis, inter alia,* has a much narrower, straight-sided, flatter prothorax, depressed in middle, the elytral costae more regular. Type in Coll. Carter. (*N.B.*—Pascoe's description of the antennae of *C. fascicularis* "basal joint longest, the rest to the tenth subequal" is inaccurate. In my example, besides the basal joint being long, both the 2nd and 3rd joints are clearly longer than succeeding joints.

CESTRINUS DENTATUS, n. sp.

Elongate, parallel, subnitid black, tarsi red.

Head and pronotum coarsely but not confluently punctate, the intervals between punctures themselves very finely punctate; 3rd joint of antennae not as long as 4th-5th combined, joints beyond 6th wanting.

Prothorax arcuate-emarginate at apex, truncate at base, anterior angles acute (less sharply than in *C. trivialis* Erich.); sides rather widely and evenly rounded, and clearly sinuate before the dentate, rectangular hind angles; margins sharply and closely crenulated.

Scutellum oval.

Elytra wider than prothorax at base, shoulders rather square, sides parallel; striate punctate, the punctures in striae large, round, uniform in size and separated by narrowly-raised cancellate ridges, intervals convex, finely and sparsely pustulose, a few very short pale hairs distinguishable at sides and apex; sternum coarsely, abdomen finely punctate. *Dimensions*: 11 x 4 mm.

Hab.—Camooweal, North Queensland.

A single specimen, given me by my friend Dr. E. W. Ferguson, is quite distinct from *C. trivialis* Erichs. (perhaps the most widely distributed Tenebrionid in Australia). After Mr. K. G. Blair's wholesome treatment of the species of this genus (these Proc., xliv., 1919, pp. 520-532) it is a daring venture to describe another *Cestrinus;* nevertheless, the above is clearly differentiated from Erichson's species by (1) the differently shaped prothorax and especially in the small posterior tooth, (2) the difference in sculpture, the punctures of the upper surface being coarser, of the lower surface finer than in *trivialis,* while in both cases they are clearly more widely separated. The pustules on the elytra are much finer and more sparse. Type in Coll. Carter.

(*N.B.*—*C. championi* Blackb. is, I consider, quite distinct from *trivialis,* not only in size, but in the system of pronotal punctures, which are not confluent, as in *trivialis,* though less widely separated than in *dentatus.* It is much more strongly bristled than *dentatus* with a differently shaped prothorax and less crenulate margins).

GONOCEPHALUM SUB-COSTATUM, n. sp.

Ovate, brownish-black, opaque, rather thickly covered with short, bristly hair.

Head: labrum prominent, clypeus sub-truncate with 4 coarse setae thereon and at sides forming an angle with the raised canthus; surface coarsely, densely punctate; antennae with 3rd joint as long as the next three combined, 4th-10th moniliform, 11th large and ovate, twice as long as 10th.

Prothorax arcuate-emarginate at apex, truncate at base, anterior angles acutely produced, sides widely rounded, widest at middle, sinuate behind, pos-

terior angles definite and obtuse; disc covered with large confluent punctures, the short bristles more obvious on margins, lateral foliation not differentiated in sculpture from disc.

Scutellum triangular.

Elytra considerably wider than prothorax at base; punctate-striate, the striae shallow, the seriate punctures large and separated by transverse ridges; all intervals granulose and bristled, the alternate four intervals rather strongly convex, forming—especially on basal area—rounded costae; underside coarsely and closely punctate; tibiae not enlarged at apex. *Dimensions*: 7-8 x 4 (vix) mm.

Hab.—Stanthorpe, Queensland (Von Wieldt).

Three examples from the Queensland Museum show a species clearly distinct from all described species, except *G. costipenne* Cart., in its sub-costate intervals, but *costipenne* has a granulose pronotum, with other marked differences of sculpture and clothing. Types in the Queensland Museum.

HYOCIS INQUILINA, n. sp.

Short and rather wide; head, prothorax and appendages pale red, elytra and underside brown, or reddish, whole surface opaque.

Head and prothorax rough, not perceptibly punctured; joints of antennae very closely adjusted, the apical four tumid.

Prothorax convex, widest near front, sides gradually narrowed behind, scarcely or very feebly sinuate behind, with clearly foliate margins; extreme edge very minutely serrate, front angles rounded, hind angles obtuse.

Elytra wider than prothorax at base, convex, slightly widened behind middle, seriate-punctate; each with about 9 rows of large, rather shallow punctures, intervals flat (or nearly so). *Dimensions*: $1\frac{1}{2}$ mm. (vix) long.

Hab.—Swan River, Western Australia, in nests of the ant *Tridomyrmex conifera* (J. Clark).

I am indebted to that indefatigable collecter, Mr. Clark, for two specimens of this interesting species. The smallest of the genus, it is easily distinguished by its almost flat elytral intervals, and short, wide form. Both *H. nigra* Blackb. and *H. minor* Cart. look comparatively large. Type in Coll. Carter.

ELASCUS MAJOR, n. sp.

Elongate, parallel, brownish-black, surface in parts thinly clad with short recumbent bristles.

Head sub-depressed in front, tuberculate near base, antennal orbits widely arched above frontal surface; eyes round, sub-conically protuberant; antennae very wide and strongly bristled except towards apex. 1st and 3rd joints longer than rest (3rd twice as long as 4th) 4th-8th successively a little narrowed, 9th and 10th slightly wider than 8th, 11th truncate, shorter and narrower than 10th.

Prothorax uneven in surface, strongly produced in middle both in front and at base; anterior angles rectangular, posterior slightly wider but clearly defined; sides nearly straight, a little widening behind, with a rather wide horizontal margin—thence rising steeply to the two irregular ridges extending from base to apex and terminating in round tubercles on anterior margin, a wide central depression, surface shagreened with some fine tubercles on margins.

Elytra considerably wider than prothorax at base, shoulders squarely rounded, sides without horizontal border; each elytron with three flexuous costae, ter-

minating near apex in small elongate tubercles, the 2nd widely interrupted in middle. *Dimensions*: 7¼ x 2 mm.

Hab.—Dorrigo, N.S. Wales. (Mr. A. E. Stephen).

I am indebted to my friend Mr. Stephen for this addition to an interesting group. It is more nearly allied to *E. crassicornis* Pasc. than to *E. lunatus* Pasc. —both of which I have from Tasmania, as well as two examples of the former from Mount Wilson (Blue Mountains)—but it is quite distinct from both in the form of antennae and prothorax, besides being larger. The specimen had been kept in a cyanide bottle so that it had little chance of retaining any pale coloured fascicles, if any existed. Type in Coll. Carter.

PLATYDEMA LIMBATUM, n. sp.

Oval, convex; whole surface, above and below, black suffused with red, nitid; elytra with a pale lateral band, antennae and legs red.

Head and prothorax thickly and rather coarsely punctate, head unarmed; antennae with apical seven joints enlarged.

Prothorax truncate at apex, base bisinuate, front corners widely rounded, hind angles rectangular, sides nearly straight, with narrow horizontal margin, deeply bifoveate at base, disc without a sign of medial line or channel.

Scutellum triangular, punctate. Elytra ovate, moderately convex, of same width as prothorax at base, greatest width behind middle, striate-punctate, the seriate punctures round and regular, intervals flat and very finely punctate. Underside minutely punctate; legs slender. *Dimensions*: 3 x 1½ (vix) mm.

Hab.—Murray River, South Australia. (Mr. A. H. Elston).

Three examples courteously sent by the discoverer can only be confused—so far as colour goes—with *P. limacella* Pasc. and its close ally *P. abdominale* Geb.; but the species is at once separated from both by much smaller size, less convex form, unarmed head of ♂, more slender antennae, differently shaped thorax and flat elytral intervals. It is the smallest of the Australian species and in form like *P. victoriae* Blackb. The red colour is most prominent on the head and pronotum, on the elytra showing only at the margins and shoulders. Types in Coll. Carter.

I have lately received from Mr. G. F. Hill of the Tropical Institute of Medicine, Townsville, several examples of what I take to be *P. deplanatum* Champ.; also an example of *P. aries* Pasc. without the usual red markings at the apex of elytra.

PLATYCILIBE TRICLAVATUM, n. sp.

Shortly ovate; head, prothorax and underside pale red, antennae and tarsi testaceous.

Head and pronotum distinctly, not closely punctate, antennae short, with the last three joints enlarged into a club.

Prothorax convex, slightly produced in middle at apex, truncate at base, sides nearly straight and narrowing to apex; all angles subrectangular; lateral border narrowly horizontal, disc without medial channel or foveae, with a row of larger lateral punctures besides the somewhat sparse and deep punctures on disc.

• *Scutellum* arcuate-triangular, with about six large punctures.

Elytra of same width as prothorax at base, oval; seriate-punctate, with some large confused punctures near base in humeral region; the surface other-

wise nitid and impunctate; underside rather coarsely punctured. *Dimensions*: 2 x 1 (vix) mm.

Hab.—Tambourine Mountain, Queensland. (A. M. Lea).

In describing *P. bicolor* (Trans. Roy. Soc. S. Aust., 1914, p. 225), while noting the difference of colour in the examples, I failed to notice that these represented two distinct species of which the description applies only (except in colour) to the darker species, with black head and pronotum with the antennae 4-clavate. *P. triclavatum* was taken in company with *bicolor*, by sifting leaf refuse. Besides colour difference and antennal joints, the prothorax is narrower, the sides straighter, the size smaller and more convex than in *bicolor*. Type in Coll. Carter.

N.B.—Both species will probably be found to require generic distinction from *P. brevis* and *P. integricollis*, but at present I am unable to give well-defined characters to separate these groups.

Pterohelaeus parvi-punctatus, n. sp.

Ovate, depressed, nitid black, antennae and tarsi red.

Head densely and clearly punctate, antennae with last four joints flattened and sub-circular.

Prothorax arcuate-emarginate at apex, anterior angles well produced and rather sharply rounded at apex, sides arcuately widened to base, posterior angles sharply falcate; foliate margins wide and concave, extreme margins reflexed, base bisinuate, disc very minutely punctate, smooth along middle, basal foveae rather deep.

Scutellum curvilinear-triangular.

Elytra of same width as prothorax at base, sides nearly straight on basal half, widely rounded behind, foliate margins wide, narrowed on apical third, thence narrowing to apex, seriate punctate, scarcely striate, with about 16 rows of small punctures (besides a short scutellary row), obsolescent at apex, intervals quite flat and almost impunctate; the 1st, 5th and 9th slightly wider than the rest; pro- meso- and meta-sternum finely transversely rugose, abdomen rather deeply longitudinally striolate. *Dimensions*: 17 x 9½ mm.

Hab.—Camooweal, North Queensland.

Two specimens had been long hypothetically labelled "*geminatus*" Blackb. in my collection. There is also a specimen in the British Museum. It is, however, a much flatter insect than *P. geminatus*, and is nearer *P. planus* Bless. but has a more nitid surface, smaller seriate punctures, and proportionally wider margins to elytra. Only under a Zeiss binocular can I make out punctures on the elytral intervals. The seriate punctures, though fine, are quite regular and there are no areas of irregular puncturation as in *P. dispersus* Macl. and others. From *P. darlingensis* mihi it differs in smaller size, wider margins, and finer sculpture throughout. Type in Coll. Carter.

Saragus pronus, n. sp.

Ovate, depressed, nitid black, tibiae piceous, antennae and tarsi red.

Head very minutely punctate, antennal orbits strongly raised and earlike, clypeus truncate in front, only separated from forehead by fine oblique side furrows, antennae with joint 3 twice as long as 4, the last three joints oval and flattened.

Prothorax arcuate-emarginate at apex, bisinuate at base, sides converging from base to apex, anterior angles well produced but rounded, posterior acute and falcate; foliate margins wide and concave, extreme border narrow and reflexed; disc smooth, a little depressed before the scutellum, a faint medial channel perceptible.

Scutellum semi-circular, smooth.

Elytra of same width as prothorax at base, wide, oval and rather flat; foliate margins as wide as those of prothorax in basal regions, narrowed, but wider than usual, at apex; a little concave in middle, flattened fore and aft; disc seriate-punctate, each elytron with 9 longitudinal series of punctures, besides a short scutellary row; of these the 9th—at junction with foliation—consists of large, deep pits; the 8th is a single row of small shallow punctures, the other series consist of irregular lines of clustered punctures—generally finer than those in 8th—in the 1st and 2nd row each forming geminate branches on basal half; all series more or less obsolescent at apex; the intervals lightly convex and smooth—flat towards apex—the first three (including the sutural) more evidently raised than the rest; prosternum with some fine pustules, abdomen finely striolate, underside otherwise impunctate and glabrous; basal joint of hind tarsi as long as the rest combined. *Dimensions*: 17 x 9½ mm.

Hab.—Flat Rock, New South Wales.

A single specimen, sex uncertain, was given me some time ago and was sent to the British Museum for comparison with a few species of which I was in doubt and returned by Mr. Blair with the note "have not." In my table (Proc. Linn. Soc. N.S. Wales, 1911, p. 197) the species would stand next to *satelles* Blackb., from which it is distinguished by its flatter form and nitid surface, together with the peculiar elytral sculpture noted above. Type in Coll. Carter.

Mr. H. W. Brown has lately taken in the Northern Territory a fine series of *Helaeus hopei* Breme and *H. crenatipennis* Cart. The former I lately identified, for the first time, in a single specimen in the Melbourne Museum. The type probably came from Port Essington.

SARAGUS ELLIPSOIDES, n. sp.

Widely oval, convex, nitid black, tarsi red.

Head finely, closely punctate, clypeal margin reflexed, evenly rounded in front, widely produced at sides before the eyes.

Prothorax strongly transverse, emarginate at apex, anterior angles very widely rounded, sides rapidly widening to base, foliate margins concave, reflexed at border, posterior angles acute, base widely bisinuate, disc microscopically punctate, with a smooth, feebly impressed medial line and two shallow basal foveae.

Scutellum transversely oval.

Elytra as wide as prothorax at base, very convex and oval, foliate margins wide at base, gradually narrowing to apical third, thence strongly narrowed to apex, finely seriate-punctate, the series broken up into confused punctures on sides and near the scutellum (here appearing to overflow on to the intervals); all intervals with a few irregular punctures, each elytron with about five very slightly raised smooth intervals, these wider than the rest; metasternum pustulose at sides; abdomen finely striolate, apical segment minutely punctate; tibiae

armed with two short spines at apex, the front tibiae with a row of fine spines on outside edge. *Dimensions*: 12 x 8-9 mm.

Hab.—Cue (H. W. Brown) and Kalgoorlie (from Mr. C. French), Western Australia.

Two examples have long been undescribed in my collection, as possibly being *S. macleayi* Blkb., but a specimen of this from Port Lincoln sent by Blackburn himself to Dr. Sharp has been sent from the British Museum and is evidently that much-named *Saragus brunnipes* Bois. *S. ellipsoides* in size and form is intermediate between *brunnipes* and *spheroides* mihi, being wider and more convex than the former, and narrower than the latter, the sculpture finer than on either, especially on pronotum which is nearly smooth. Type in Coll. Carter.

NYCTOZOILUS PUNCTO-COSTATUS, n. sp.

Elongate-ovate convex, opaque black, antennae piceous, legs and tarsi clothed with golden hair.

Head coarsely, irregularly punctate; clothed with short golden bristles; clypeus arcuately hollowed in front, labrum strongly produced, ciliate and punctate; antennae with 4 apical joints transverse and paler than the rest, 3rd joint longer than 4th-5th combined.

Prothorax arcuate-emarginate at apex, truncate at base, anterior angles acutely produced; sides widely rounded, sinuate behind; widest behind middle, posterior angles acute; disc very densely punctate, lightly depressed in middle with large shallow depression on each side; margins sub-foliate—separated from disc by light depression—extreme border rather thick on sides, less so at base and apex. *Scutellum* transversely triangular, coarsely punctate.

Elytra wider than prothorax at base, each with four nitid and punctate straight costae, more or less evenly spaced, and uniformly raised, the suture also nitid and punctate, but less raised than costae; interspaces with opaque derm, densely pitted with shallow punctures; underside clothed with short golden hairs, the abdominal sculpture somewhat like that of the elytral intervals. *Dimensions*: 15 x 7 (vix) mm.

Hab.—Wyndham, North West Australia. (W. Crawshaw).

Mr. J. Clark has generously given me an example of the above—sex doubtful—that is quite unlike any described species. In my table (Ann. Q'land Mus., 1911, p. 10) it would come nearest to *N. hardcastlei* and *N. vermiculatus* mihi, but clearly separated from both by narrower form, and the 8-costate elytra, *inter multa alia*. Type in Coll. Carter.

NYCTOZOILUS DENTICOLLIS, n. sp.

Widely obovate, opaque black above, nitid beneath, apical joints of antennae reddish.

Head and pronotum with an impunctate felt-like surface, epistoma truncate in front, widely rounded at sides, little raised at antennal orbits, 3rd antennal joint almost as long as the succeeding three; 4th-7th longer than wide, 8th-10th subspherical, 11th ovoid.

Prothorax (5 x 7 mm.), apex widely emarginate, with acutely produced dentate angles pointing forwards and upwards; base sub-truncate, much wider than apex, posterior angles moderately dentate, pointing obliquely outwards; sides strongly widened near middle, sinuately narrowing each way, extreme border

rather narrow, margins entire, reflexed, with wide concavity within, disc with two deep foveae symmetrically placed slightly behind middle—no sign of medial line.

Scutellum widely transverse.

Elytra of same width as prothorax at base and more than thrice as long, obovately widened and very convex behind; disc with three well marked, undulate costae, the first two connected at base, and near apex, the 3rd originating behind shoulder, the suture forming thicker geminate costae (without undulations), these bifurcating behind scutellum and joining 1st costa near base; interspaces reticulate-foveate, with one or two transverse cancellations and many smaller, less raised reticulations; a row of large lateral punctures and a small row of similar punctures within the post-scutellary costae. Abdomen minutely punctate and striolate; sternum and epipleurae smooth; fore- and mid- tibiae slightly bowed, hind-tibiae straight, all without tomentum; hind tarsi with basal joint as long as the rest combined. *Dimensions*: 19 x 10 mm.

Hab.—Stanthorpe, Queensland (Von Wieldt).

A single ♀ example in the Queensland Museum shows a species easily distinguished by its smooth, unpunctured pronotum, large size and obovate form. In my table it would follow *N. vermiculatus* Cart. Type in the Queensland Museum.

NYCTOZOILUS MARGINATUS, n. sp.

Ovate, subopaque black, apical joint of antennae and extreme apex of palpi reddish.

Head densely and finely punctate, epistoma truncate in front, oblique on sides, canthus well raised in front of eyes; antennal joints more slender, and elongate than in *N. denticollis*; 3rd joint about as long as next two combined, 4th-7th elongate, 8th widely ovate, 9th-10th subspherical, 11th ovate-acuminate.

Prothorax (4½ x 8½ mm.) widest at middle, anterior angles produced and rounded, base slightly wider than apex and bisinuate, posterior angles forming an acute tooth produced backwards; sides moderately rounded, without sinuation; extreme margins entire, very thick and round, raised and finely punctate, widely concave within, this gutter transversely rugose; disc densely punctate and finely rugose with a smooth medial line terminating behind in a foveate depression, a wide shallow depression on each side of medial line.

Scutellum very transverse.

Elytra wider than prothorax at base and four times as long, ovate and convex, sides evenly rounded; each elytron with 4 well raised shining, undulate costae, besides the sutural geminate costae, bifurcating behind scutellum and joining 1st costa at base; 1st and 2nd (also 2nd and 3rd) costae connect by lateral ridge at base, the 4th (less raised), near extreme border, originating behind shoulder and terminating on apical declivity; interspaces irregularly reticulate; and having the usual lateral row of punctures. Abdomen longitudinally striolate and very minutely punctate. Sternum smooth; front tibiae arcuate, middle straight, hind tibiae wanting—the two former tomentose within. *Dimensions*: 20 x 10 mm.

Hab.—Wyreema, Queensland. (O. W. Tiegs).

A single ♂ example, in the Queensland Museum, labelled as above, is also very distinct from described species by its combination of large size, evenly rounded pronotum with thick margins, and the 8-costate, reticulate elytra. In my

table it should be placed next *N. daemeli* Haag, from which its size alone will distinguish it. Type in Queensland Museum.

BRISES GRANULATUS, n. sp.

Oblong ovate, depressed, dark castaneous, moderately nitid; antennae, tarsi and underside of femora paler.

Head sparsely punctate, antennae not extending to base of prothorax, joint 3 longer than 4-5 combined, the five apical joints submoniliform.

Prothorax narrower than in *B. acuticornis* Pasc., apex arcuate, base subtruncate, anterior angles rounded, posterior rather widely acute, sides gently arcuate, a little sinuate behind. Disc finely punctate—more distinctly so than in *B. acuticornis*—medial channel faintly indicated; a subhorizontal depression near base, the punctures coarser along this area.

Scutellum semi-elliptic, transverse and punctate.

Elytra wider than prothorax at base, the suture and eight subcostae on each lightly raised—the alternate subcostae more strongly so—a row of granules along each subcosta as also on suture, the costae obsolete and indicated by rows of granules only towards apex; between each pair of subcostae two rows of punctures of a size clearly larger than those in *B. acuticornis;* gular region transversely rugose, rest of underside lightly punctate. *Dimensions*: 17 x 7 mm.

Hab.—Broken Hill, New South Wales. (Mr. R. J. Burton).

Four examples examined, of which three were sent by Mr. Burton; the fourth had been long in my collection, given to me by the late Mr. G. Masters amongst some *B. laticornis* and labelled S. Australia. The species is clearly distinct from all described species, of which representatives of each are before me. In general shape and nitid surface it is most like *B. acuticornis* Pasc., in elytral sculpture nearer *B. parvicollis* Blkb., but with the granules much more accentuated—somewhat as in *Pterohelaeus bullatus* Pasc. Type in Coll. Carter.

HYPAULAX NANUS, n. sp.

Obovate, opaque black, elytra a little nitid, apical joints of antennae and tarsi red.

Head finely, not densely punctate, clypeal suture shallow, forehead flat.

Prothorax: apex and base feebly bisinuate, anterior angles advanced but rounded, sides strongly widened at middle, thence narrowing each way—obliquely in front, sinuately behind—posterior angles subrectangular, not produced; lateral and basal border thin and lightly raised; disc minutely and evenly punctate, a medial depression shown near base, two round foveae—one near centre of each lobe—and two small transverse basal foveae.

Scutellum widely transversely triangular.

Elytra obovate, wider than prothorax at base, seriate punctate, with 8 rows of foveate punctures—besides a row at junction of epipleurae; lateral rows substriate, interspaces uneven and finely punctate; anterior tibiae of ♂ a little bowed, sternum smooth, abdomen of ♂ distinctly and sparsely punctate, of ♀ only the apical segment very closely and minutely punctate. *Dimensions*: 8-9½ x 4-5 (vix) mm.

Hab.—Northern Territory. (H. W. Brown).

Four examples, two of each sex, have been examined. It is like a miniature *H. insularis* Hope, with the following differences: *Prothorax* widest in middle

(widest behind middle in *insularis*) all its angles less wide; *Elytra,* seriate punctures finer, the intervals finely punctate (smooth in *insularis*).

The elytral surface is uneven through each fovea forming a pit around which the area is slightly tumid, the combined effect being very different from the convex interval of a striate species. Types in Coll. Carter.

N.B.—In the abdominal sculpture of *H. insularis* Hope there is a similar sexual difference to that noted above, but to a greater degree—the ♂ having rather coarse sparse punctures. My remarks on this point in my revision of the genus (Proc. Linn. Soc. N.S. Wales, 1914, p. 63) apply therefore only to the ♀.

CARDIOTHORAX COERULESCENS, n. sp. (Text-fig. 7.)

Shortly ovate, nearly black with blue reflexions, nitid.

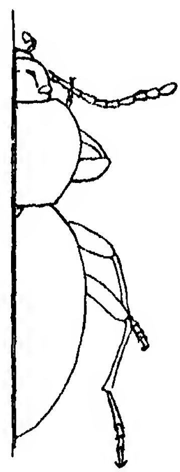
Head: clypeus rounded, usual frontal impression well marked, with a few punctures near its base.

Prothorax cordate, widest about middle, arcuate at apex, sub-truncate at base, foliate margins narrow, sides narrowly sinuate behind; anterior angles subrectangular, posterior deflexed and obtuse, without distinct tooth, disc smooth, medial channel defined, a small fovea on each side (sometimes wanting).

Elytra wider than prothorax at base, ovate; each with nine fine sulci—ninth on sides—intervals equal, very lightly convex. Legs fine, without sexual characters, tibiae straight, underside smooth. *Dimensions*: 11-12½ x 4-4½ mm.

Hab.—Eungai (north of Kempsey), New South Wales. (Mr. T. G. Sloane).

Four examples, taken by Mr. Sloane (July, 1920), show a small metallic species near *iridipes, metallicus* and *coeruleo-niger.* The first and third of these, however, have clearly dentate hind angles to prothorax and the third also has only 6 clearly impressed sulci on each elytron; *metallicus* Cart. has a clearly arcuate or sub-angulate base to prothorax, the posterior angles wider and not bent downwards as in the above species. Type in Coll. Carter.



Text-fig. 7.
Cardiothorax coerulescens, n.sp.

ADELIUM MUREX, n. sp.

Brilliant violet-bronze, nitid, pilose; antennae, underside, legs and tarsi metallic black, the last clothed beneath with red tomentum, whole body more or less clothed with long upright, dark hair.

Head coarsely punctate, the punctures neither close nor regular; foveae at corners of clypeal suture strongly setiferous, 3rd antennal joint as long as 4th-5th combined.

Prothorax sub-truncate at base and apex, widest near middle, thence rather abruptly narrowed each way, sinuate near base, all angles obtuse, disc very coarsely punctate-rugose, the punctures more thickly placed than in *A. scutellare* Pasc. or *A. pilosum* Pasc., the rugosity consisting of smooth sub-vermiculate ridges, chiefly conspicuous towards base, foliate margins not differentiated from disc save by less coarse sculpture and transverse ridges.

Scutellum smooth, broadly triangular.

Elytra oblong-ovate, seriate, foveate-punctate; with rows of large punctures, somewhat uneven in size, becoming still larger—with a tendency to confluence—towards sides; intervals raised and crenulate, the lateral intervals—from the 6th outwards—subcostate, the intervals bearing scattered setae, more numerous at sides; post-intercoxal process truncate, prosternum, epipleurae and femora punctate, the punctures less coarse than on upper surface, abdomen finely punctate. *Dimensions*: 15 x 6 mm.

Hab.—Wyreema, Queensland.(O. W. Tiegs).

A single ♂ specimen in the Queensland Museum shows a species that is a close ally of Pascoe's *A. scutellare* in size, form and hairy clothing. The chief difference lies in (1) the much more closely punctured and rugose pronotum, (2) the quite different and unique elytral sculpture; besides the colour in which it is the most brilliant of the genus. Type in the Queensland Museum.

SEIROTRANA NODICAUDA, n. sp.

Elongate, parallel, bronze, nitid, glabrous.

Head irregularly punctate, forehead with some smooth spaces and a few large round punctures, base and clypeal depression with close, smaller punctures, extreme base finely pustulose; antennae sub-moniliform, joint 3 little longer than 4, apical joint ovate-acuminate.

Prothorax: apex arcuate-emarginate, anterior angles acute, base feebly bisinuate and about as wide as apex; posterior angles also acute, but wider than the anterior; sides very slightly arcuately enlarged on anterior half and feebly sinuate near base; extreme margin fine and feebly undulate; disc irregularly punctate, with larger foveate punctures scattered amongst a closer system of minute puncturation, the foveate punctures smaller towards sides; a medial channel indicated on front half.

Scutellum transverse, minutely punctate.

Elytra of same width as prothorax at base, sides parallel to apical third, disc with surface uneven, some irregular tumours taking the place of the usual longitudinal nodules, giving rise to the occasional interruption of the series of large round punctures—these rows, as usual, in pairs; the intervals quite impunctate and nitid; the apical declivity showing large oval nodules (about 6 on each apex). Epipleurae and episterna coarsely, abdomen very finely, punctate. *Dimensions*: 9 x 4 mm.

Hab.—Stanthorpe, South Queensland. (Von Wieldt).

A single example in the Queensland Museum is quite distinct from any others of the genus by its combination of small size and curiously sculptured elytra. The surface is not as in *S. parallela* Germ. (and many others), but the feeble elevations are diagonal or sub-vermiculate, except towards apex, where the oval nodules are even larger than the corresponding ones in *S. parallela.* Type in Queensland Museum.

LICINOMA SUB-CANALICULATA, n. sp.

Elongate oblong, nitid, bronzy black, antennae and tarsi piceous.

Head coarsely punctate, clypeus arcuately hollowed out in front, its sides oblique, rhomboidal frontal impression well marked and limited in front by deep sulcus; antennae moniliform—the apical joint moderately larger (much smaller than in *L. nitida* Pasc.).

Prothorax longer than wide, truncate at apex and base, widest in front of middle, sides lightly rounded, scarcely sinuate behind, anterior angles blunt, posterior widely obtuse; disc rather sparsely and coarsely punctate with a few foveae; medial line shallow, more or less clearly impressed but not continuous to front margin and terminating near base in a shallow transverse impression.

Elytra wider than prothorax at base, subparallel for the greater part, shoulders distinct though rounded; striate punctate, the striae deeply impressed, seriate punctures round and uniform, intervals with a single line of almost microscopic punctures, the 3rd and 5th each with two large setae; epipleurae coarsely, abdomen finely punctate. Posterior tarsi with 1st joint shorter than claw joint. *Dimensions*: 9-10 x 3 mm.

Hab.—Victoria: Mount Macedon (C. Deane and J. E. Dixon) and Gisborne (J. E. Dixon), Gippsland (J. E. Dixon), Jamieson (H. J. Carter).

Seven examples under examination. Since publishing my revision of the genus (These Proc., xlv., 1920, p. 237) I could not resist a lingering doubt that the above species might be *L. nitida* Pasc. on account of its habitat, so sent a specimen to Mr. Blair for careful comparison with Pascoe's type. Mr. Blair, however, corroborates his former opinion and writes "Your *Licinoma* from Mt. Macedon . . . . is certainly different from Pascoe's Mt. Macedon species. Cf. shape of thorax, particularly posterior angles." I can only conclude, therefore, that either Pascoe's locality is wrong, or—what is much more likely—that the ranges of the two species overlap. I have *L. nitida* (= *victoriae* Blkb.) from Dandenong Ranges, Mt. Buffalo, Wandin, Olinda Creek, and Gippsland in Victoria and from Mt. Kosciusko and Eden in N.S. Wales.

L. sub-canaliculata is clearly separated from *L. nitida* by (1) darker colour of surface and antennae, (2) longer and more coarsely punctate pronotum, the latter also longer and channelled, (3) elytra more deeply striate, its intervals more finely punctate. Pascoe's words "antennae ferruginous, the last joint large and as long as the two preceding together" are entirely inapplicable to my species.

From *L. meridiana* Cart.—to which it is more closely allied—it differs in the truncate apex and more rounded sides of prothorax, with its disc more sparsely punctate; elytral striae less deep, seriate punctures more widely separate (in *L. meridiana* they are very close, while the interstices appear quite smooth). Types in Coll. Carter.

BRYCOPIA CAPILLATA, n. sp.

Ovate, dark bronze, nitid, apical joints of antennae red, whole upper surface clothed with long upright hairs.

Head coarsely and closely punctate, antennae moniliform, apical joint considerably larger than the rest.

Prothorax subcordate, truncate at base and apex and about equally wide at each, widest before the middle, anterior angles obtuse, sides crenulated, rather widely rounded on anterior half thence, at first obliquely, later sinuately narrowed before the small subrectangular posterior angle—this forming a small tooth more or less outwardly directed; disc convex, coarsely, not very closely, punctate (more densely so towards the sides) and slightly rugose, without foveae or medial line; sides without clear foliation, extreme margins finely crenulate.

Scutellum large, scutiform, with a few large punctures.

Elytra slightly wider than prothorax at base, shoulders rather squarely rounded; striate-punctate, the seriate punctures close, round and regular—of the

same size as those on pronotum,—alternate intervals (3rd, 5th, 7th) and suture slightly raised, each interval with a single row of punctures, not much smaller than those in the series, each bearing a hair. Legs also with long hairs; episterna coarsely, abdomen (at sides) more finely punctate; hind tarsi with basal joint shorter than the rest combined. *Dimensions*: 6 x 2.3 mm.

Hab.—Stanthorpe, South Queensland. (Von Wieldt).

I have examined seven examples, sent from the Queensland Museum, of this very distinct little species. It is nearest to *B. pilosella* Pasc. and *B. comata* Cart., but is readily separated from the former by its darker colour (especially its dark appendages) and unusual elytral sculpture. *B. comata* Cart. is quite black, with elytral intervals convex and wrinkled. The small but distinct tooth at hind corners of prothorax will also serve to differentiate *B. capillata* from both. Types in Queensland Museum.

CHALCOPTERUS SCUTELLARIS, n. sp.

Elongate oblong, sub-cylindric, whole upper surface (except head) dark peacock blue—elytra sometimes green or purplish-green or coppery at sides, scutellum coppery, antennae, legs and underside black, tarsal clothing red.

Head punctate, eyes separated by the length of 1st antennal joint; antennae with joint 3 not as long as 4-5 combined, 4-10 subequal in length but successively widening.

Prothorax truncate at apex, feebly sinuate at base, widest behind, thence gently narrowing to apex; surface finely, closely punctate, with smooth medial space on basal half.

Scutellum brightly metallic, smooth.

Elytra little wider than prothorax at base, about twice as long as wide; seriate-punctate, intervals flat; seriate punctures round, small and close in 1st row, larger and more widely separated towards sides; intervals very finely and closely punctate; underside finely striolate. *Dimensions*: 11 x 4¾ mm.

Hab.—Kimberley, N.W. Australia (Mr. Crawshaw), Cairns, Queensland, and Northern Territory.

Near *C. gracilis* Blackb. in form and sculpture, but distinguished by its black abdomen and the bright metallic scutellum which is shown in the nine examples under examination. Types in Coll. Carter.

CHALCOPTERUS TORPEDO, n. sp.

Narrowly elliptic, uniformly dark blue above, black beneath, antennae brownish, legs red—the knees and tarsal claws obfuscate; tarsal clothing pale red.

Head closely and finely punctate, eyes widely separated (intervening space the length of 3rd antennal joint); antennae, joint 3 as long as 4-5 combined, 4-11 short, subequal in length but moderately and successively widened.

Prothorax unusually convex, a little arched at sides, these converging towards apex, hind angles rectangular from above; disc uniformly, closely punctate, with a distinct smooth, medial line, slightly raised in parts; two triangular basal foveae.

Scutellum triangular, smooth, metallic.

Elytra scarcely wider than prothorax at base, sub-cylindric for basal two-thirds, thence finely narrowed to apex; striate-punctate, the striae shallow; seriate punctures round and large (as in *C. iridicolor* Bless. but more closely set), both

punctures and striae continuous to, but becoming finer at, the apex; under a lens the slightly convex intervals seen to be closely, very finely, punctate. *Dimensions*: 10 x 4 mm.

Hab.—North Queensland. (Mr. H. Dodd).

A single example is in size and form not unlike the former (*C. scutellaris*), but clearly distinct in its striate elytra, larger seriate punctures and red legs. It is quite unlike any of the other red-legged species. Type in Coll. Carter.

AMARYGMUS METALLICEPS, n. sp.

Elongate elliptic, convex, whole upper surface (including head) brilliantly metallic, the prevailing tints being head green, pronotum purplish, elytra green with iridescent purple gleams, golden at suture; underside and legs black, tarsal clothing dark.

Head clearly, uniformly punctate, eyes widely separated by a space of the diameter of one eye; antennae with joint 3 scarcely longer than 4; joints 4-7 subequal in length, slightly widening outwards, other joints wanting.

Prothorax short, transverse, sides straight, narrowing from base to apex, posterior angles acute (from above); disc finely and closely punctate.

Scutellum punctate.

Elytra a little wider than prothorax at base; seriate-punctate, seriate punctures close, round and regular (somewhat as in *C. purpureus* Germ. but smaller); intervals flat, finely and closely punctate. *Dimensions*: 7-9 x 3½-4 mm.

Hab.—W. Australia: Cue (H. W. Brown); South Australia: Tarcoola and Cleve.

Three examples, one from each of the above localities, are, I think, conspecific, though the Cue example (the type) has rather finer seriate punctures, and the Cleve example has its lateral elytral intervals sub-convex. Type in Coll. Carter.

N.B.—*Amarygmus tarsalis* Pasc. has been lately identified (by comparison with type) from Wauchope and Munanbang, N.S. Wales.

CISTELIDAE.

Chromomoea mastersi Macl. This is a good species, quite distinct from *C. deplanchei* Fauv., though given as a variety of that species in my Revision (Proc. Roy. Soc. Vict., 1915, p. 60).

The following differences may be noted:—

	C. deplanchei.	*C. mastersi.*
Antennae.	Black, joints 4–9 pear-shaped, successively increasing, 10 similar but smaller; 11 finely pointed.	Basal joints (at least) yellow or red; joints 4–10 linear, 7–10 gradually thinner but of equal length, 11 about ⅔ length of 10.
Prothorax.	As wide as long.	Longer than wide.
Elytra.	Intervals flatter.	Intervals more convex and punctulose.
Legs.	Black.	Red.

C. mastersi is not uncommon near Sydney. I have beaten it from *Casuarina* foliage, and besides the types from Gayndah, there are in the Australian Museum examples from Bombala, N.S.W., and N. Queensland.

CHROMOMOEA TIBIALIS, n. sp.

Elongate, glabrous; head, elytra, underside and appendages pale red; prothorax reddish, with medial area slightly infuscate.

Head densely and finely punctate, eyes large and prominent; antennae with joints 3-8 elongate linear, successively shorter and wider, 9-10 triangularly widened, 11 as long as 10, acuminate.

Prothorax longer than wide, truncate at base and apex, sides nearly straight, a little narrowed in front, hind angles rectangular; whole disc fine and confluently punctate.

Elytra navicular, wider than prothorax at base, striate-punctate; the seriate punctures comparatively large, close and regular, the intervals sub-convex—with a line of sparse punctures on each—with an occasional extra puncture: sternal area closely, the episterna very densely, punctate; abdomen sparsely so. Post-tibiae enlarged exteriorly into a wide triangular lobe, inner surface hollowed. *Dimensions*: 7 x 2 mm.

Hab.—Cairns, Queensland.

A single male example, from a forgotten source, was amongst my series of *C. mastersi* Macl. from which it is clearly distinguished by (1) colour, (2) longer and finer antennal joints, (3) more densely punctured pronotum, (4) glabrous surface and (5) tibial sex character. Type in Coll. Carter.

Homotrysis aerea, n. sp.

Elongate, obovate, whole body nitid, coppery bronze, glabrous, antennae and tarsi red.

Head finely, not densely, punctate; eyes very large, bordered within by a sulcus, separated by a space less than (in ♂), or equal to (in ♀) the width of one eye; antennae linear, each joint lightly thickened at apex, joints 3-11 successively shorter, 11 lanceolate.

Prothorax subquadrate in ♂, more widened in ♀, apex truncate (or feebly advanced in middle), front angles rounded, base truncate, posterior angles rectangular, sides in ♂ nearly parallel, in ♀ clearly rounded; disc with light sparse, shallow punctures, larger at base, obsolescent towards apex, a lunate transverse depression near base, a smaller transverse depression near apex (sometimes indicated only by two foveae) and (in general) two small central foveae.

Scutellum semicircular, smooth.

Elytra considerably wider than prothorax at base, shoulders rather square, sides gradually widening to near apex; striate-punctate, each elytron with 9 striae, besides a short scutellary stria; the punctures round, deep and fairly uniform, the series irregularly interrupted by a raised connection between the intervals, the latter impunctate and nearly flat, except at sides. Meso- and metasternum with a few coarse punctures; abdomen striolate; fore-tibiae of ♂ dentate in the middle, within; the middle and hind-tibiae lightly curved; in ♀ all tibiae unarmed and straight. *Dimensions*: 15-16 x 5-6 mm.

Hab.—Port Macquarie (Dr. E. W. Ferguson) and Eungai (T. G. Sloane), New South Wales.

Five specimens examined (3 ♂, 2 ♀). It is readily distinguished from the rest of group i. in my tabulation (Proc. Roy. Soc. Vict., 1915, p. 79) by its brilliant bronze, glabrous surface and the tibial tooth in the male. Types in Coll. Carter.

Homotrysis aenescens, n. sp.

Elongate obovate, brownish bronze, subnitid, tarsi (also tibiae in male only) reddish.

Head closely punctate (more finely and densely on clypeus than on forehead), eyes very close in ♂, much more widely separated in ♀, antennae lineate, joints 3-11 successively shorter than preceding.

Prothorax subarcuate at apex (feebly advanced in middle), feebly bisinuate at base, sides slightly rounded on front, half-arcuate narrowed in front—nearly straight on basal half; posterior angles (seen from above) rectangular, disc closely and strongly (not contiguously) punctate, with short, pale, sparse, recumbent hairs; medial depression well marked in ♂, feebly indicated in ♀; a wide transverse depression near base and 2 shallow discal foveae.

Scutellum arcuate-triangular, closely punctate.

Elytra obovate, wider than prothorax at base, and 3½ times as long; humeri tumid; punctate-striate, each with 8 striae—besides a short scutellary stria and a lateral row of punctures; the seriate punctures large and rectangular on basal half, separated by transverse cancellations, but gradually obsolescent towards apex; intervals coarsely punctate, the interstitial punctures each bearing a short hair similar to those on pronotum; sternum coarsely, abdomen finely punctate; protibiae of ♂ widened (subdentate) on inside. *Dimensions*: ♂. 15 x 5½; ♀. 16 x 6 mm.

Hab.—Stanthorpe, Queensland (Von Wieldt).

A pair of this fine species sent by Mr. Hacker, shows a species distinct in colour, sculpture and sexual characters from all its congeners—except *debilicornis* Haag.—and from *debilicornis* by larger size, different antennae and sexual characters. Compared with *H. cisteloides* Newm. the eyes of ♂ are much closer, the pronotum is more closely and finely punctate, the seriate punctures of elytra are much larger, the interstices more convex and more coarsely punctate. Types in the Queensland Museum.

CERAMBYCIDAE.

Piesarthrius (*Anotisis*) *frenchi* Blackb. Mr. John Hopson has recently found this fine longicorn breeding in *Diospyros Cargillia* * in the dense brush of the mountain gullies near Eccleston, Allyn River, New South Wales. Originally described from Queensland, its occurrence as far south as the Hunter River basin is noteworthy. As the male only was known to Blackburn, I append a description of the female, generously given me together with its mate by Mr. Hopson.

♀. Antennae extending to four-fifths of the body, all joints sub-linear, 1-10 expanded at apex, 5-10 subdentate at interior apex, 3-10 subequal, 2nd longer than 3rd, constricted and knobbed at base, 11th cylindric, as long as but narrower than 10th, other characters as in ♂. *Dimensions*: 34 x 10 mm.

The male specimen exactly corresponds in size with that of the described type, *i.e.* 32 x 8 mm. (16 x 4 lines).

*For the determination of this tree I am indebted to my friend, Mr. J. H. Maiden, F.R.S., of the Sydney Botanic Gardens. Mr. Hopson informs me that the local name is "Black Plum," and that bullock drivers use it for whip handles. It seldom grows beyond 3-4 inches in diameter.)

NOTES ON THE GENUS *FLINDERSIA* (FAMILY *RUTACEAE*).

By C. T. White, F.L.S., Government Botanist of Queensland.

The genus *Flindersia* was founded by R. Brown (Flinder's Voyage, ii., 1814, p. 595) on *Flindersia australis,* the common "Crow's Ash" of Queensland or "Teak" of Northern New South Wales.

The genus is preponderatingly Australian; of the 18 species known only 3 are found outside Australia. All the Australian species are found in Queensland and 6 of them extend into New South Wales. The genus contains some of the most important timbers of Eastern Australia, as "Crow's Ash" or "Teak" (*F. australis*), "Yellow Wood" (*F. Oxleyana*), "North Queensland Maple" (*F. Brayleyana*), "Silk Wood" (*F. Pimenteliana*), and "Silver Beech" or "Putt's Pine" (*F. acuminata*).

A monographic account of the genus by C. De Candolle appeared in De Candolle's Monographiae Phanerogarum, i., pp. 728-735, and full accounts of the Queensland and New South Wales species in F. M. Bailey's "Queensland Flora," Pt. i., pp. 238-243 and J. H. Maiden's "Forest Flora of New South Wales," Vols. i-iii.

There has been considerable confusion in regard to some of the tropical sorts and the present paper is offered as a contribution towards clearing up some of these difficulties. As several new species have been described since the publication of De Candolle's Monograph and several of the species named by Bailey are here reduced to earlier named species a revised list of species and their varieties is given herewith.

In regard to two of the species in the following list, viz.: *F. pubescens* and *F. Strzeleckiana,* I am aware that they would be classed by many botanists as varieties, if not actually only forms, of *F. Schottiana* and *F. maculosa* respectively, and I had myself at first decided to class them as varieties; as, however, they can both be readily distinguished from their nearest allies, I have left them with full specific rank, especially as both are trees of economic importance, the former for timber, shade and ornamental purposes and the latter for fodder and, to a less extent, for timber and shade in inland parts. The general use of botanical names for economic plants is becoming more and more common every day among the general public; varietal names are cumbersome and their application to economic plants except where unavoidable would in my opinion seem unwise.

1. *F. acuminata* C. T. White. (Qland Dept. Agric., Botany Bull. xxi., p. 5, Pl. 2). North-eastern Queensland.
2. *F. amboinensis* Poir. (in Lam. Encycl., Suppl. iv., 650). Amboina.
3. *F. australis* R. Br. (in Flind. Voy., ii., 595, tab. i.). Eastern Australia.
4. *F. Bennettiana* F. v. Muell. (Fragm. Phytogr. Austr., v., 133). Eastern Australia.
5. *F. Bourjotiana* F. v. Muell. (Fragm. Phytogr. Austr., ix., 133). North-eastern Queensland.
6. *F. Brayleyana* F. v. Muell. (Fragm. Phytogr. Austr., v., 143). North-eastern Queensland.
   F. Chatawaiana Bail. = *F. Brayleyana.*
7. *F. collina* Bail. (Qland. Agric. Jour., iii., 354). Eastern Australia.
8. *F. Fournieri* Panch. et Seb. (Bois Nouv. Cal., 228). New Caledonia.
9. *F. Ifflaiana* F. v. Muell. (Fragm. Phytogr. Austr., x., 94). North-eastern Queensland.
10. *F. laevicarpa* C. T. White & W. D. Francis (Qland Agric. Dept., Bot. Bull. xxii., 8, with plate). North-eastern Queensland.
11. *F. Leichhardtii* C.DC. (in DC. Monogr. Phanerog., i., 731). Queensland. This plant is quite unknown to me and I cannot place it from De Candolle's description.
    F. maculata F. v. M. = *F. maculosa.*
12. *F. maculosa* F. v. Muell. (Fragm. Phytogr. Austr., i., 65). Inland New South Wales and Queensland.
    F. Mazlini Bail. = *F. Pimenteliana.*
13. *F. Oxleyana* F. v. Muell. (Fragm. Phytogr. Austr., i., 65). Eastern Australia.
14. *F. papuana* F. v. Muell. (Descript. Notes Pap. Plants, i. (v.), 84). Papua.
15. *F. Pimenteliana* F. v. Muell. (Fragm. Phytogr. Austr., ix., 132). North-eastern Queensland.
16. *F. pubescens* Bail. (Qland. Agric. Journ., iii., 353).
    F. radulifera Spreng. = *F. amboinensis* Poir.
17. *F. Schottiana* F. v. Muell. (Fragm. Phytogr. Austr., iii., 25). Eastern Australia.
    F. Schottiana F. v. M. var. *pubescens* F. v. Muell. (Fragm. Phytogr. Austr., v., 143) = *F. pubescens* Bail. North-eastern Queensland.
18. *F. Strzeleckiana* F. v. Muell. (Fragm. Phytogr. Austr., i., 65). = *F. Strzeleckiana* F. v. M. var. *latifolia* Bail. = *F. collina.*
    F. Tysoni C.DC. = *F. Bourjotiana* F. v. Muell.

Notes on some of the Species.

FLINDERSIA PIMENTELIANA.

F. v. Mueller, Fragm. Phytogr. Austr., ix., 1875, 132; C. De Candolle, in DC. Monogr. Phanerog., i., 1878, 732; Bailey, Synop. Qland Fl., 1883, 64; Qland Fl., 1899, 240.—*F. Mazlini*, Bailey, Qland Agric. Journ., v., 1899, 388, and xxx., 179, Pl. 24, 25; Qland Fl., i., 240; J. F. Bailey, Qland Agric. Journ., v., 1899, 395, Pl. 138, fig. 3; N. W. Jolly, Forestry Bulletin No. 1, Brisbane, 1917, p. 6, with photomicrograph of timber.

Hab.—Mt. Macalister (J. Dallachy), Evelyn (J. F. Bailey), Atherton Tableland (H. W. Mocatta).

This tree is commonly known in Northern Queensland as "Silkwood;" Mueller described the species from flowering specimens, immature fruit only being available to him. Bailey originally described his *F. Maslini* from fruiting specimens only, but later he redescribed and illustrated it from complete material. In his figure (drawn by the present writer) the hispid or hyaline hairs situated on the filament just below the anther are not shown; these, however, are easily rubbed or broken off in the older flowers.

FLINDERSIA BOURJOTIANA.

F. v. Muell., Fragm., x., 1875, 133; C. De Candolle, in DC. Monogr. Phanerog., i., 1878, 732; Bail., Syn. Qland Flora, 1883, 64; Cat. Queens. Woods (various editions), No. 73A; Queens. Flora, i., 1899, 241.—*F. Tysoni*, C. De C., in Bull. de l'Herb. Bois., 2nd Ser., vi., 1908, 986..

Hab.—Ranges about Rockingham Bay (J. Dallachy), Johnstone River (Dr. T. L. Bancroft, H. G. Ladbrook, Rev. N. Michael), Herberton (H. W. Mocatta), Mossman River [H. Tryon; not Tyson as spelt by De C., (ex Nat. Herb. Syd.)].

Through the kindness of Mr. J. H. Maiden, I.S.O., F.R.S., I have been able to see part of Tryon's material collected on the Mossman River, and cannot see how De Candolle's species can be separated from the common North Queensland *F. Bourjotiana*. The only difference I can find is that Mueller, in his original description, states "petalis intus imberbibus" whereas De Candolle states "petalis intus inferne dense villosis." The only flower available to me on Tryon's specimens, however, showed no signs of pubescence or tomentum on the inner face of the petal. The species is most readily told by its very thick, coriaceous leaves with the veins scarcely or not all discernible on either face. It comes very close to *F. Schottiana*, but when once seen can be readily told by the above character.

FLINDERSIA BRAYLEYANA.

F. v. Muell., Fragm. Phytogr. Austr., v., 1866, 143, and vi., 1868, 252; C. De Candolle in DC. Monogr. Phanerog., vi., 1868, 252; Bail., Syn. Qland. Flora, 1883, 64; Qland Flora, i., 1899, 241.—*F. Chatawaiana* Bail., in Queens. Agric. Jour., v., 1899, 387; Qland Flora, i., 1899, 240; J. F. Bailey, Queens. Agr. Jour., v., 1899, 395, Pl. 138, fig. 2; N. W. Jolly, Forestry Bull. No. 1, p. 6, with photomicrograph of timber (Brisbane, 1917) and Bulletin No. 2, p. 15; No. 3, p. 15 (Brisbane, 1917).

Hab.—Herbert River (J. Dallachy), Rockingham Bay (J. Dallachy), Middle Tully River, Atherton, Martintown, Barron Valley and Evelyn (J. F. Bailey), Atherton Tableland (H. W. Mocatta).

From an examination of Mueller's type material of *F. Brayleyana*—possible through the kindness of Prof. A. J. Ewart—I have come to the conclusion that the name of *F. Chatawaiana* must lapse. The tree is one of the most important timber species in North Queensland and is known as "Red Beech" or "North Queensland" or "Cardwell Maple."

The species is readily distinguished by the smooth blunt tubercles or mussel-like scars of the capsule-valves, well depicted in J. F. Bailey's figure quoted above.

FLINDERSIA SCHOTTIANA.

F. v. Muell., Fragm., iii., 1862, 25, and ix., 1875, 133; C. De Candolle in DC. Monogr. Phanerog., i., 1878, 733; Bail., Syn. Qland Flora, 1883, 64; Qland Flora, i., 1899, 241; Cat. Queens. woods (various editions), No. 71; J. F. Bailey, Qland Agr. Jour., v., 1899, 395; Maiden, Forest Flora of N.S.W., ii., 1906, 155, Pls. 69, 70.

Hab.—A common tree in Queensland and New South Wales. Speaking of its distribution in the latter State, Maiden states "In New South Wales it does not appear to have been recorded south of the Hastings River. From thence it is not uncommon in brush forests to the Queensland border." In Queensland it is an exceedingly common tree; the northernmost record is the Herberton District (J. F. Bailey). The tree is commonly known as "Cudgerie" or "Bumpy Ash." Some of the northern forms are clothed on the under surface of the adult leaves with a very close, exceedingly dense velvety tomentum and it is possible that when further material is available it may have to constitute a distinct variety or varieties.

FLINDERSIA PUBESCENS (F. v. M.)

Bail., Queens. Agric. Journ., iii., 1898, 353, and x., 1902, 47, Pl. i; Comprehens. Cat. Qland. Plants, 1913, 91, Pl. 4; N. W. Jolly, Forestry Bulletin No. 1, p. 7, with photomicrograph of timber (Brisbane, 1917).—*F. Schottiana* var. *pubescens*, F. v. Muell., Fragm. Phytogr. Austr., v., 1866, 143.

Hab.—Rockingham Bay (Dallachy), Hinchinbrook Island (*ex.* Nat. Herb. Melbourne), Trinity Bay, Cairns (W. Hill, E. Betche), Martintown (J. F. Bailey), Kairi (C. T. White).

This tree was originally described by the late F. M. Bailey from trees cultivated and raised in a Brisbane Park from seed collected in North Queensland. He described it under the name *F. pubescens* correctly thinking it identical with *F. Schottiana* var. *pubescens* F. v. Muell. In my opinion Bailey was justified in raising it to specific rank. It is characterised by its very large leaves and leaflets. The leaf rachis and petiole are densely clothed with a soft golden-brown stellate pubescence; the under surface of the leaves is clothed with stellate hairs; the veins, and to a less extent the veinlets, are prominent on the under surface.

As cultivated in Brisbane, *F. Schottiana* flowers in November, *F. Schottiana* var. *grandis*, a month to six weeks earlier. This latter is a noble tree and is quite common in cultivation about Brisbane where it does remarkably well. As a street tree its only drawback is that the large hairy leaves catch and hold a fair amount of dust and dirt.

The following are the chief differences between *F. Schottiana* and *F. pubescens*:

Leaflets on flowering shoots, subcoriaceous, somewhat falcate, 2½-5 inches (6.5-13 cm.) long, ¾-1¼ inches (2-3.3 cm.) broad; quite glabrous or the rachis and under surface clothed with a very close and dense stellate, velvety tomentum, veins and veinlets not prominent and often scarcely discernible .. .. *F. Schottiana.*

Leaflets on the flowering branches chartaceous, 5-9 in. (12.5-23 cm.) long, 1¾-2½ in. (4.5-6.5 cm.) broad, rachis densely clothed with comparatively long golden-brown stellate hairs, under surface clothed with numerous but more or less scattered stellate hairs, the veins and veinlets prominent .. .. *F. pubescens*

FLINDERSIA COLLINA.

Bail. Qland Agric. Journ., iii., 1898, 354; Qland Flora, i., 1899, 242; Maiden, Forest Flora of N.S.W., iii., 13, Pl. 81, 82.—*F. Strzeleckiana* F. v. Muell. var. *latifolia* Bail, First Suppl. Synops. Qland. Flora, 1886, 12; Cat. Qland. woods. (various editions, 1886-1890), No. 730.

The oldest name for this species is *F. Strzeleckiana* var. *latifolia* Bail. The name should therefore be *F. latifolia;* the tree is so well known now however as *F. collina* that no good would seem to result from the change.

Vernacular Names.—It is most commonly known as the "Leopard wood," a name however also applied to *F. maculosa;* it is also known as "Scrub Leopard wood" and "Broad-leaved Leopard wood." Writing from Benarkin, Southern Queensland, Asst. Forester F. H. Weatherhead informs me that the tree is variously known there as "Leopard wood," "Carpet Snake wood," "Nut wood," "Maul wood," "Long Jack" and "Lance wood." At Nanango, Mr. C. H. Grove informs me it is known as "Bastard Crow's Ash" or "Leather wood."

Hab.—Maiden records it for New South Wales only from the Tooloon Ranges. His remarks "growing in the foothills in dense scrubs it appears to be a very rare tree," though they may apply in New South Wales, do not in any way apply to the tree as it occurs in Queensland, it being one of the commonest trees in the south-eastern parts of the latter State, very plentiful in the drier and thinner scrubs, as those of Benarkin, Rosewood, Nanango, Theebine, etc.

In the Queensland Herbarium we have it from as far north as Childers (Mr. R. Helms) and Mt. Perry (J. Keys), and as far west as Taroom,—about 200 miles inland (— Patullo).

FLINDERSIA MACULOSA (Lindl.).

Benth., Fl. Austr., i., 1863, 389; C. De Candolle in DC. Monogr. Phanerog., i., 1878, 734; Bail., Syn. Queens. Flora, 1883, 64; First Suppl. Syn. Qland Flora, 1886, 12; Qland Flora, i., 1899, 243; Cat. Qland woods (various editions), No. 73; Comprehens. Cat. Qland Pl., 1913, 91 and 97, tab. 73 bis; Maid., Forest Flora N.S.W., i., 209, Pl. 39; R. T. Baker, Hardwoods of Australia, 1919, 73.—*F. maculata*, F. v. Muell., in Quart. Jour. Trans. Pharm. Soc. Vict., ii., 1859, 44.—*Elaeodendron maculosum,* Lindl., in Mitch. Trop. Austr., 1848, 384,—oldest name.

Hab.—Maiden records it for New South Wales as "Found over a large area of the Western Division, *e.g.* in the vicinity of the Darling, Lachlan, Macquarie, Castlereagh and other inland rivers." As regards Queensland we only have it from St. George, Southern Queensland (J. Wedd), Barcaldine, Central Queensland (W. D. Francis), and between Emerald and Longreach, Central Queensland (E. Jarvis).

FLINDERSIA STRZELECKIANA.

F. v. Muell., Fragm., i., 1859, 65 and ix., 1875, 133; C. De Candolle in DC. Monogr. Phanerog. Austr., i., 1878, 734; Bail., First Suppl. Syn. Qland Flora, 1886, 12; Qland Flora, i., 1899, 243; Cat. Qland woods (various editions), No. 73B; Comprehens. Cat. Queens. Pl., 1913, 91 and 97, tab. 73.

Hab.—We have it in the Queensland Herbarium from the Leichhardt District (F. M. Bailey), Jericho (W. D. Francis), and Clermont (Mrs. Small). I

think it advisable to keep these two trees distinct, the following character well marking the one from the other.

Leaves simple .. .. *F. maculosa.*
Leaves all or nearly all 3-5 foliolate, rarely a few simple or unifoliate *F. Strzeleckiana.*

Doubtful Species.

Flindersia papuana, F. v. Muell., Descript. Notes on Papuan Plants, i., (v.), 1877, 84.

Mueller named this species from a single immature fruit only. While collecting in Papua in August, 1918, I gathered fruit-valves of a *Flindersia* off the ground in a rich rain forest between Okaka and Mafulu (inland from Yule Island) but failed to get foliage or flowers. Mr. E. Stanley, Govt. Geologist of Papua, who was with me at the time, informed me however that the tree is not at all uncommon in the country west of Hall Sound and has promised to try and send complete specimens. The fruit-valves are the largest of any *Flindersia* yet described, my specimens measuring 7¼ to 8½ ins. (18.5-30 cm.) long, 1½-2 ins. (3.8-5 cm.) broad and 9-10 lines (2-2.3 cm.) deep.

DESCRIPTION OF A NEW TIGER-BEETLE FROM THE WYNDHAM DISTRICT.

With some notes on recent works on Australian *Cicindelidae.*

By THOMAS G. SLOANE.

(One text-figure.)

CICINDELA CLARKI, n. sp.

Subcylindrical; prothorax with a strong anterior and posterior transverse impression; elytra convex, strongly and densely punctate; head and pronotum asetose, sternal side parts, lateral parts of ventral segments 1-4, and coxae bearing white setae; antennae slender; labial palpi with penultimate joint elongate (but not slender), apical joint short; mentum with median tooth short, triangular; labrum 7-dentate with four marginal setae; four anterior trochanters asetose. Upper surface cupreous (sometimes elytra rather aeneous) under surface metallic blue tending to green on sides; labrum lacteous with a large dark semicircular basal area; each elytron with two white spots on apical half,

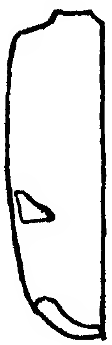


Fig. 1.

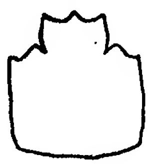


Fig. 2.

Fig. 1. Left elytron, to show the pattern. Fig. 2. Labrum, to show shape.

the anterior spot lateral, broader than long, not touching external margin nor extending inward to half the width of elytron, apical spot forming a wide margin along apical curve reaching inward almost to suture; trochanters piceous, femora green, tibiae and tarsi bluish.

♂. Head 2.5 mm. across eyes, concave and striolate between eyes; occiput transversely rugulose; labrum large, median part porrect, parallel on sides, with three subequal prominent teeth, a short seta on each side of apical tooth, incision between second and third teeth deep, narrow, asetose, posterior tooth prominent, placed just before middle of length, emargination before it bearing a short seta. Prothorax as long as broad (1.5 x 1.5 mm.); disc strongly convex, slightly rugulose. Elytra much wider than prothorax (4.5 x 2.5 mm.); puncturation very strong and rather uneven. Length 7-9, breadth 2.5-2.7 mm.

Hab.—North West Australia: Wyndham and Forrest River. Several specimens were sent to me by Mr. John Clark of Perth, Western Australia.

Allied to *C. oblongicollis* Macl., of which *C. tenuicollis* Macl., is considered by Dr. W. Horn to be a red form. From *C. leai* Sl., to which it is closely allied, it differs by size larger, labrum with median apical part more prominent, all the teeth and the notches between them more strongly developed, labial palpi with penultimate joint longer and not so thick, more setose; prothorax with middle part more convex, transverse impressions deeper; elytra with apical white spots larger, extending along the whole length of the apical margin, but separated from one another at the suture; abdomen with a lateral white stripe of setae along the sides of segments 1-4 (In *C. leai* there are only four or five separate white setae on the side of the basal segment). From *C. tenuicollis* Macl., it differs even more markedly than from *C. leai* by size large; labrum larger and with apical median part more prominent; white spots of elytra larger. The wide continuous lateral stripe on each side of ventral segments 1-4 is also a conspicuous difference. In *C. tenuicollis* there are (from a damaged specimen in my collection) a few white setae on the sides of segments 1 and 2.

CICINDELA RAFFLESIA Chaudoir.

Specimens in my collection (♂, ♀) from Carnarvon differ from specimens from northern Queensland by having the metallic parts of the pattern cupreous, not viridaeneous; and by having the four anterior trochanters each with a fixed seta, not only the trochanters of the fore-legs. In these characters I have not found any variation amongst the eastern specimens which I have been able to examine, but the eastern and western specimens are certainly conspecific, though it has yet to be discovered whether the range of *C. rafflesia* is continuous from Cape York Peninsula to Carnarvon.

Notes.

(1). In 1915 Dr. Walther Horn published the third part of his magnificent monograph of the family *Cicindelidae**. In this masterly work Dr. Horn records all the *Cicindelidae* of the world known to 1915 (including all species, and subspecies, with their synonymy); he gives tables of the tribes, subtribes, and genera, but not of the species. In part iii. he deals with the subtribe Cicindelina (three genera, viz., *Cicindela* with about 595 species, and about 260 chief races, *Eurymorpha* and *Apteroessa* with 1 species each. He uses the genus *Cicindela* in its widest sense (including in it 29 synonyms and 13 "groups" which various author's have thought worthy of distinct names), and to render it less difficult to make out the species of this immense genus he treats the species of each

*Wytsman's Genera Insectorum. Col. Adeph., Cicindelidae, W. Horn. Fasc. 82^A (1908), 82^B (1910), 82^C (1915); 486 pp., 23 plates.

faunal region separately, dividing them into numerous independent groups, using the fixed hairs of the four anterior trochanters for his primary group-character. Dr. Horn records 68 species† of the genus *Cicindela* from the Australian faunal region as a whole; these he divides into 27 groups, of which 12 groups containing 25 species are represented in Australia. Dr. Horn's grouping of the Australian species agrees substantially with the system of groups adopted by me in my Revision of the *Cicindelidae* of Australia in 1906, but he does not recognise my *Cicindela-spuriae* and-*verae*, and he arranges the species in a different order. He also uses more groups than I would. The following are his changes from my system:—*C. doddi* is united with the *C. oblongicollis*-group; *C. discreta*, *C. semicincta*, *C. blackburni*, *C. browni*, *C. frenchi* and *C. darwini* constitute separate monotypic groups. Dr. Horn's groups are more constricted than mine, but I think he is right in segregating *C. frenchi* and *C. darwini*.

(2). Mr. A. M. Lea (Trans. Roy. Soc. South Aust., 1917, pp. 121-125) published some notes on Australian *Cicindelidae*, when he described 2 new species, viz., *Distypsidera pictipennis* (allied to *D. gruti* Pasc. from Stewart River, north of Cooktown) and *Cicindela antiqua* (allied to *C. albicans* Chaud., from Derby, N.W. Australia). He also suggests that *C. albicans* is a variety of *C. ypsilon* Dej., and that *C. plebeia* Sl., should be considered distinct from both *C. mastersi* Cart. and its subspecies *C. catoptriola* Horn.

(3). Prof. Mjoberg (Arkiv för Zoologi, Band 10, 1916) gives a list of the species of *Cicindelidae* collected by him in Australia from 1910 to 1913, describing 2 species as new, viz., *Megacephala kimberleyensis* (Fitzroy River, N.W. Australia) and *Distypsidera sericea* (closely allied to *D. parva* Macl., from Malanda, North Queensland).

(4). Dr. Walther Horn (Arkiv för Zoologi, Band 13, 1920) reviewed Mjoberg's notes on Australian *Cicindelidae*, making critical remarks on the species, and pointing out some errors of identification made by Mjoberg, also describing as new *Megacephala sloanei* (allied to *M. intermedia* Sl., from Australia).

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†Since Dr. Horn's work in 1915 the following species have been described from Australia:—*C. gilesi* Sl., *C. aeneodorsis* Sl., *C. antiqua* Lea, and *C. clarki* Sl.

THE ACTIVE PRINCIPLE OF *ERYTHROPHLOEUM LABOUCHERII.*

By James M. Petrie, D.Sc., F.I.C., Linnean Macleay Fellow of the Society in Biochemistry.

(*From the Physiological Laboratory of the University of Sydney.*)

(Plates xxiii.-xxiv., and two Text-figures.)

Erythrophloeum Laboucherii is the Ironwood tree of the Northern Territory and Queensland. It was first described by Baron von Mueller (2), in 1859, under the name of *Laboucheria chlorostachya,* and subsequently as *E. chlorostachys* (F. v. M.) Baillin, and *E. Laboucherii* F. v. M. The latter is the name used in Bentham's Flora Australiensis, in the Index Kewensis and Engler's Botany (1).

This tree is a member of the family Leguminosae and is often referred to as Leichhardt's leguminous ironbark tree, or the ironwood tree. Besides the original latin description by von Mueller, the leaves, flowers and pods are figured in the same author's work on Australian Acacias (3) and reproduced, with further notes, in the Queensland Agricultural Journal by F. M. Bailey (7). It is also described in the Queensland Flora (5) and in Bailey's Weeds and Poisonous Plants of Queensland, with an illustration (6). (*See* Plate xxiii.)

Planchon, in 1907, described with great detail the comparative anatomy of *E. chlorostachya, E. guineense, E. couminga,* and *E. Fordi,* in a French publication, and a full abstract of this (9) may be seen in Just's Jahresbericht for 1908.

At the beginning of an investigation of this kind where much time and labour may be expended on one particular plant, it is of importance to have some general knowledge of the genus to which it belongs. In many instances information of much value is obtained by a consideration of the position of a plant relative to the other species, and by a knowledge of the prominent characteristics, or of any remarkable properties which may have been recorded for other members of the genus. With this object the following data have been collected regarding the world distribution of the genus *Erythrophloeum.*

This genus appears to be confined to the Old World, and 12 species are known. In the great forests of Central Africa grows the dreaded ordeal tree of the pigmies, *Erythrophloeum guineense,* and all parts of this tree have long been known to contain a very poisonous alkaloid, named erythrophleine.

Three other species belonging to tropical Africa are *E. purpurascens* Chev., *E. ivorense* Chev., and *E. pubistanineum* Henn., but the nature of their juices is unknown.

In Madagascar is found *E. couminga* Baill.; then crossing into Asia, we find in Further India and China five different species, *E. Fordi* and four others.

Descending to the Philippine Islands one species is met with, *E. densiflorum* (Elmer) Merrill. This plant has been investigated chemically in 1917 by Brill and Wells (20), who found, however, that it contained no poisonous substance. In this species the alkaloid of *E. guineense* was proved absent.

On continuing southwards we meet with the single Australian species *E. Laboucherii,* in Northern and Tropical Australia.

The powerful and poisonous alkaloid, which was first discovered in *E. guineense* of Central Africa, has since been identified also in *E. couminga* of Madagascar, and *E. Fordi* of China. It was proved absent in the Philippine species, and all the others are quite unknown.

With regard to the Australian species the writer has found no record of any experimental work having been done. The Botanist Baron von Mueller is quoted in "Wittstein" (4) as having said that an alkaloid was present in this plant, but beyond this single statement there is no reference to any evidence for its support, and in all probability the remark is founded on analogy alone.

E. Laboucherii is endemic in Northern Australia. It has been found along the whole vast stretch of coast land beginning about Vansittart Bay, the most northerly part of Western Australia, where it was first collected by Allan Cunningham. It continues through the Northern Territory, and flourishes in abundance up the Victoria River and the Roper and Endeavour Rivers, where it was observed by Banks and Solander. It grows on all the great rivers which flow into the Gulf of Carpentaria, and was collected by Robert Brown on the numerous islands in the Gulf. It grows richly in the York Peninsula and is still very plentiful down the east coast of Queensland to the Tropic of Capricorn. Dr. Shirley states that south of Rockhampton it occurs only very sparsely, and rapidly disappears. It is exceedingly rare to find it in south-east Queensland. On Plate xxiv. are photographs of a tree and a close view showing the characteristic bark.

Many Australian trees have been designated ironwoods, but here the name of ironwood tree is peculiarly appropriate, for the red-coloured wood is exceedingly hard, and is probably the hardest of all Australian timbers.

It was used by the aborigines for making their womerahs and spear-heads.

Though this plant was collected by the great Botanists in the early days of Australian Settlement and described in detail by Mueller in 1859, there appears no account of its poisonous properties until comparatively recent years.

F. M. Bailey has described the tree as one of the worst poisonous plants of Queensland, and how large numbers of stock are yearly lost from eating its leaves. He also described how the tree forms numerous leafy shoots near the ground by sprouting from the roots. These masses of young green foliage, therefore, are very accessible to sheep and cattle, and are the chief cause of mortality.

Ten thousand sheep were lost on Cambridge Downs through eating the leaves of this tree. The Stock Inspector who reported the above tremendous loss stated that two leaves were sufficient to kill a goat (7).

Bennett, in 1904, wrote that this plant had proved most disastrous to the camels imported to carry the copper ore from Mt. Garnet (8).

Mr. Meston, formerly Protector of Aborigines of North Queensland, wrote in 1909 that " the bark, wood, leaves, fruit and flowers of this tree are deadly poisonous. Its peculiar property is that it absolutely destroys the optic nerve and one bean mixed in your food would make you totally blind. A splinter from the tree needs about the same treatment as snakebite" (10). It is employed by the natives for criminal purposes.

Mr. Allen, Director of the Botanic Gardens of Darwin, writes that this tree has been very troublesome of late, many sheep, horses, and cows having died from eating the young leaves.

THE ALKALOID OF THE CENTRAL AFRICAN SPECIES: *Erythrophloeum guineense.*

Erythrophloeum guineense is one of the group of poisonous plants used by the pygmies in Central Africa in the preparation of their arrow poisons. It is well known too from its use for criminal purposes. It is the *Nkasa,* the "doom tree" of the West African natives, who use it in the trial by ordeal to detect persons accused of sorcery and witchcraft or other crimes. The bark alone is used for this purpose. A small piece is removed and pulverised; an infusion of this is made, and the accused persons are forced to drink a certain quantity. The general result of drinking this infusion is a rapid appearance of symptoms of poisoning. The first stage is characterised by violent vomiting, but, if a small dose only has been given, these symptoms may disappear and the person recover, in which case he is declared innocent and set free. If, however, a larger dose has been administered, the second stage is rapidly reached in which the vomiting and purging continue, all power is suddenly lost from the limbs and the person falls to the ground. He is then considered guilty of the crime and is either at once put to death, or quickly dies of heart-paralysis, the effect of this powerful draught.

A vivid description of a trial by ordeal in the Gold Coast is to be found in the Pharmaceutical Journal for 1856, where it may be read with all its gruesome details (11).

The ordeal tree was first examined chemically in 1876 by Gallois and Hardy of Paris (12). Their first experience while working with this material was the violent fits of sneezing produced by the powdered plant, and great care had to be taken to prevent the dust penetrating the respiratory passages. An intensely poisonous alkaloid was isolated which was named "erythrophleine" by the authors. Neither the base nor its salts could be obtained in crystalline form, and the alkaloid was found in the bark, leaves and seeds. It was stated to be a powerful heart-poison.

During the same year, E. Merck, of Darmstadt, prepared a large quantity of erythrophleine, and this was distributed to pharmacologists in various countries. From this material Lauder Brunton (13) made a very extensive examination of the physiological properties of the alkaloid. The chief conclusion arrived at was that erythrophleine possessed the pharmacological properties of both the digitalis and the picrotoxin groups in its action on animals. He emphasised also the effects on the respiratory organs: "All the men employed by us in grinding or pounding the bark suffered severely from the violent and irresistible fits of sneezing which attacked them, and in one instance these were accompanied by great faintness and tendency to syncope."

In 1888 there was a large production of published papers in medical literature on the use of erythrophleine as a therapeutic agent. It was employed in heart diseases as a cardiac tonic. It was said to have no cumulative action and therefore, a valuable substitute for digitalis. It was found to have a considerable anaesthetic action like cocaine. It possessed certain local irritant properties when injected subcutaneously or instilled into the eye.

In 1895 Merck succeeded in preparing a new supply of alkaloid, which he purified with extreme care, and with this, Harnack, in 1895 (16), proved that the picrotoxin action was eliminated, and the pure digitalis action alone was exhibited. Even with this pure substance the alkaloid was amorphous and its salts could not be crystallised.

Harnack determined the approximate composition of the base from the analysis of its amorphous platinum salt, and from these results the formula was provisionally expressed as $C_{28}H_{43}O_7N$.

Power and Salway (19) in 1912, from bark collected in the Belgian Congo, isolated an alkaloid which agreed in its properties and composition with that of Harnack. These two authors worked also on a commercial specimen obtained from Merck. Merck prepared the hydrochloride salt with dry gas: the salt was obtained in the form of a viscid oil and not as before in the amorphous solid state (18). This hydrochloride gave the formula $C_{28}H_{43}O_7N.HCl$ with 6.9 % Cl (19).

The free alkaloid erythrophleine was obtained by precipitating the aqueous solutions of its salts by alkalies. The first flocculent precipitate soon collected into a resinous mass, and finally changed to a thick yellow syrup. It was very soluble in alcohol, ether, ethyl acetate and dilute acids, but insoluble in petroleum spirit or benzene. The substance was very easily decomposed, evaporation in a solution which was not quite neutral being sufficient to change it partly. When heated with acids or alkalies, the solution became yellow, then a brown resinous substance separated, which cooled to a hard brittle solid. This was erythrophleic acid, $C_{27}H_{40}O_8$. It was nitrogen-free, and nearly insoluble in water and acids. It was soluble in alcohol, ether and alkalies. When erythrophleine was heated in this way for a short time only, the nitrogen-free acid which was obtained reduced Fehling's solution, but when the heating was continued to complete destruction of the alkaloid there was no reduction. The reducing was, therefore, due to some intermediate product, which was gradually destroyed. This decomposition was also accompanied by the evolution of a volatile base, which, in the case of material from certain sources, was a nicotine-like base called manconine, and with that obtained from other sources was shown to be methylamine.

Experimental.

The problem presented is to determine by practical experiment whether the Australian tree, *Erythrophloeum Laboucherii,* owes its poisonous properties to the presence in it of some definite chemical compound like the alkaloid of *E. guineense,* and whether such an alkaloid, if present, is identical with the erythrophleine isolated from that plant.

The material for this investigation was kindly offered by Mr. J. H. Maiden, Director of the Sydney Botanic Gardens. The plant was collected at the beginning of 1920 by Mr. Allen, Curator of the Botanic Gardens of Darwin, in the Northern Territory. To both, the writer takes this opportunity of expressing his indebtedness and thanks.

The sample consisted of a small amount of air-dried leaves and a few beans.

Preliminary Tests.—An extract was prepared by macerating a small amount of the leaves, and also of the beans, in alcohol. When the solvent was distilled and the solid extract treated with slightly acidulated water, a solution was obtained which gave very strong indication of the presence of an alkaloid in considerable amount.

The alkaloid was contained in the leaves and, in relatively greater quantity, in the beans.

The characteristic tests for other active plant-principles gave negative results: cyanogenetic glucosides and saponins were proved to be absent.

The amounts of ash and water contained in the leaves and beans were estimated.

	Leaves.	Beans.
The air-dried powder contained water	8.73 %	10.1 %
,, ,, ,, ash	2.45	2.5

Extraction of the alkaloid.

The leaves and fruits were treated separately. The air-dried material was brought to a state of fine powder by passing through a grinding mill, and during this operation considerable discomfort was produced by the irritating effects of the dust on the mucous membranes.

The powdered plant material was transferred to large percolators and macerated with cold 70 % alcohol: this procedure was continued till the spirit drawn off ceased to contain alkaloid. In this way 24 litres of alcoholic extract were obtained, and this was distilled under reduced pressure at a temperature below 40°C.

The residue in the stills consisted of a thick black tarry mass, and this was poured into hot water. When the aqueous mass was left to settle a considerable quantity of resins was deposited, and this was washed repeatedly by decantation till the fluid no longer gave alkaloid reactions. The washings were concentrated and added to the main fluid.

This clear aqueous fluid was dark red in colour, slightly acid in reaction, and gave strong evidence of the presence of an alkaloid.

The faintly acid, aqueous fluid was then completely shaken out with ether in successive small volumes which removed colouring matter, chlorophyll, resins and fatty oils. This acid ethereal extract, measuring 10 litres, when distilled and dried, left a hard brown solid mass, weighing 20 gms.

The aqueous fluid was then made alkaline with sodium carbonate, and again extracted with ether, until the last ethereal solution contained no alkaloid. In this way the whole of the alkaloid was removed by the ether. The voluminous ethereal solution was distilled, the ether recovered, and the viscous syrup remaining in the still was transferred to a beaker. This residue which was dark brown in colour and resinous, was treated with faintly acidulated water, in which the alkaloid dissolved, leaving the resinous portion insoluble. From this acid solution the whole of the alkaloid was precipitated by sodium carbonate: it was then removed in solution by shaking up with ether, and the ethereal fluid distilled to dryness. This dry residue was pale amber-coloured and entirely amorphous, and when a second time it was extracted with acidulated water, sodium carbonate precipitated the alkaloid in white flocculent particles. These were removed, and dissolved in ether, from which the alkaloid was finally obtained as a white horny substance. It was then dried and weighed.

The yield of alkaloid.—From 2.8 kilograms of the leaves 56 milligrams of the amorphous alkaloid were obtained, or 0.002% of the air-dried leaf-powder.

The beans gave a much larger quantity—290 grams of this material yielded 87 milligrams of the alkaloid, or 0.03% of the air-dried beans.

Properties of the alkaloid.

Physical.—The substance obtained by evaporation of the ethereal solution from the leaves, and that from the beans, appeared to be identical, and consisted of a semi-transparent amorphous mass, almost white in colour.

It was soluble in alcohol, ether, ethyl acetate, chloroform, amyl alcohol and acidulated water, but quite insoluble in distilled water alone.

The solutions of the base exhibited a strong alkaline reaction and possessed an intensely bitter taste. The dilute acid solutions were readily and completely precipitated by sodium carbonate, or sodium hydroxide, while ammonium hydroxide

precipitated only concentrated solutions. These precipitates were white opaque flocculent masses, which on standing in the air for a short time became viscous.

Chemical.—Very dilute solutions of the salts of the alkaloid gave dense precipitates with the following characteristic reagents:—Wagner's solution, Mayer's solution, phosphotungstic acid, phosphomolybdic acid, picric acid, and tannic acid.

Sulphuric acid produced a bright yellow colour.

Potassium permanganate and concentrated sulphuric acid yielded a deep purple to red solution, somewhat similar to the strychnine reaction, with very slow reduction of the reagent.

Potassium bichromate and concentrated sulphuric acid rapidly produced a greenish blue colour which remained permanent.

The preparation of the hydrochloride of the alkaloid was next tried. About 40 milligrams of the pure dry amorphous alkaloid were dissolved in dry ether. Into this solution was passed a current of pure, dried, hydrochloric acid gas. A brown oily sediment gradually settled to the bottom of the vessel and on removal of the ether there was left a brown viscous residue which on examination proved to be the hydrochloride of the alkaloid. Many attempts were made to crystallise this substance, but it still retained its viscous nature. Nor were the efforts to transform it to sulphate and picrate salts more successful.

Determination of the chemical equivalent.—For this purpose a portion of the purified white amorphous alkaloid was dissolved in pure ethyl alcohol and water, treated with excess of centinormal hydrochloric acid, then carefully neutralised with centinormal soda and methyl orange indicator.

0.08 gm. alkaloid required for neutralisation .. .. 8cc. .01N HCl
equivalent to 0.0029 gm. HCl
100 gms. alkaloid would require .. .. 3.64 „
1000 gms. alkaloid would require .. .. 36.4 „
1 mol. wt. = 36.4 „

In formula [B].HCl equivalent weight of alkaloid = 1000 (approx.)
„ $[B]_2.HCl$ „ „ = 500 „

Examination of the remaining solutions.

The ethereal extract, previously obtained by shaking out the acid solution with ether, was distilled, and from this 20 gms. of residue were obtained. This residue was redissolved in ether and treated with sodium carbonate solution. The alkaline liquid was agitated and run off a number of times, and these various solutions were notable for their brilliant colours, varying from *violet* to *crimson-red.* All these colours, however, soon became a uniform *reddish-brown,* and when the solutions were acidulated with hydrochloric acid, a dark brown oil formed on the surface, and a light *brown* curdy precipitate was deposited.

This precipitate was soluble in alkalies and alcohol, forming a deep *red* solution. Concentrated sulphuric acid also dissolved it as a bright *yellow* solution, which on dilution formed a *violet* precipitate; and ferric chloride produced an intense *green* colour.

The aqueous solution, after extracting the alkaloid with ether from the alkaline solution, possessed a deep *red* colour, was free from the bitter taste of the original solution, and gave no alkaloidal reactions. It was precipitated by lead acetate solution, and after the removal of the lead by hydrogen sulphide in the usual way, both precipitate and filtrate were examined.

The lead acetate precipitate.—The concentrated solution was shaken out with ether 10 times. This ethereal solution was a deep *yellow* colour and was next agitated with (*a*) ammonium carbonate, and (*b*) sodium carbonate.

(*a*). The ammonium carbonate extract was acidulated with sulphuric acid, shaken out with ether, and the solvent distilled. A buff-coloured crystalline residue was obtained, which was difficult to purify. This substance was soluble in water, alcohol, ether, chloroform, acetone and ethyl acetate, but these solvents dissolved both crystals and impurity together, and recrystallisation did not improve the appearance of the crystals. The aqueous solution was next digested with animal charcoal, and filtered. During the filtration the *colourless* solution became *purple*, the first washing with water yielded a *blue* solution, and the second washing became *green*.

The crystals which were obtained after this treatment were still impure. The aqueous solution was acid to litmus and possessed a hot peppery taste. It gave a negative reaction with Molisch's test. The crystals were lath-shaped with pointed ends and occurred in groups of rosettes. After drying at 100°C., the melting point was tested, when it was found that at 172°C. some change took place, resulting in the formation of a white sublimate in the tube, and a white film round each crystal. About 216°C. the substance melted and charred.

The neutralisation equivalent was obtained by titrating 14 milligrams of the crystals with 6.5 c.c. of centinormal soda, which gave 216 as the molecular weight of the acid. The amount of material was too small for further investigation.

(*b*). The sodium carbonate extract also exhibited the brilliant colours. For example, the first addition gave a bright *violet* (permanganate) colour to the alkaline solution, the second addition yielded a deep *green* colour which rapidly changed to *cherry-red*. Acidulated with sulphuric or hydrochloric acid the solution was *yellow*, and when reshaken with ether the ethereal solution also was a bright *yellow* colour. When filtered the latter solution became *red* and *violet* by oxidation. On evaporation the ether left a *red* solid. This substance was soluble in dilute ammonia forming a deep *reddish-violet* colour, gradually becoming *brown* on standing. This, on acidulating with sulphuric acid, gave an intense *yellow* colour.

The lead acetate filtrate.—This was shaken out with ether many times, and the ethereal solution after concentration was agitated successively with ammonium carbonate, sodium carbonate, and caustic soda. These solutions when acidified with sulphuric acid and agitated with ether, after distillation left a small oily residue of a dark brown colour.

Luteolin, and other colour substances.—These various alkaline liquids with the many different colours ranging from *yellow, green, blue,* to *violet* and *red* all gradually changed to a uniform *brownish-red* colour on standing for some time, and the acidulated solutions gave *brown* precipitates.

Certain of the above remarkable colour changes, and the reactions described, correspond to those obtained for the yellow dye *luteolin* by Power and Salway (19) in their investigation of *Erythrophloeum guineense.* These authors obtained a very small amount of luteolin from a large quantity of the plant, and they showed that it existed in the plant as a glucoside.

Conspicuous evidence of the presence of other powerful colouring matters was shown, but the amount obtained was not sufficient for further examination.

The aqueous solution remaining from the lead acetate filtrate after agitating with ether, contained much sugar.

PHYSIOLOGICAL ACTION OF *ERYTHROPHLOEUM LABOUCHERII.*

J. M. Petrie and H. Priestley, M.D., Ch.M., B.Sc., Associate Professor of Physiology.

(*a*) *External Action.*

The powdered leaves act as a violent irritant. During the grinding and drying of the material for analysis all those who came in contact with the fine dust, or inhaled the air of the room in which the powder was spread out to dry, suffered from violent fits of sneezing. In one case [J.M.P] the action of this irritating dust on the respiratory mucous membranes was so severe as to incite acute bronchial inflammation.

(*b*) *Action on cardiac muscle of the Frog.*

A solution of the purified hydrochloride salt of the alkaloid was prepared by dissolving it in 0.7% sodium chloride solution, that is, a physiological normal saline solution containing 0.5% of the alkaloid.

In a pithed frog the heart was exposed and the apex attached to a writing lever. After recording the normal beats for a short time the prepared alkaloid solution was dropped on the heart, from 2 to 4 drops being applied.

Exp. 1.—*Hyla aurea,* weight 12 gms.

Time	Heart-beats. per min.	Observations.
	64	Exposed heart beating regularly.
after		4 drops of alkaloid solution applied to heart.
5 secs.	70	
1 min.	58	Diastole incomplete.
6 mins.	24	Liver engorged, sinus venosus dilated.
		Convulsions
		Prolonged systole.
7 mins.		Heart stopped for 5 secs. in diastole.
10 mins.	0	Heart stopped in systole.
11 mins.		Fibrillar twitchings of the heart.

The diastolic standstill for 5 secs. was probably a result of stimulation of the vagus centre. Partial contractions of the auricles continued after the ventricle had stopped in complete systole.

Exp. 2.—*Hyla aurea,* weight 12 gms. (*See* diagram.)

Time	Heart beats	Observations.
	48	Normal heart.
after		Applied 4 drops of alkaloid solution.
1 min.	48	
2 ,,	45	
3 ,,	38	Convulsive movements.
6 ,,	36	
7 ,,	0	Heart stopped, with ventricle slightly contracted.

In this instance when the heart stopped the ventricle was irregularly contracted, and it contained blood in small isolated patches, especially about the base. The diagram shows the record at the beginning, middle, and end of the experiment. The mark under the top line indicates where the alkaloid was applied.

Exp. 3.—*Hyla aurea,* weight 17 gms.

Time	Heart beats	Observations.
after	68	Normal heart. 4 drops alkaloid solution applied to heart.
1 min.	60	
2 ,,	54	Beats became weaker.
2½ ,,	30	Convulsive movements.
4 ,,	0	Heart stopped in systole.

The diastole became less perfect, and the systole stronger and more perfect.

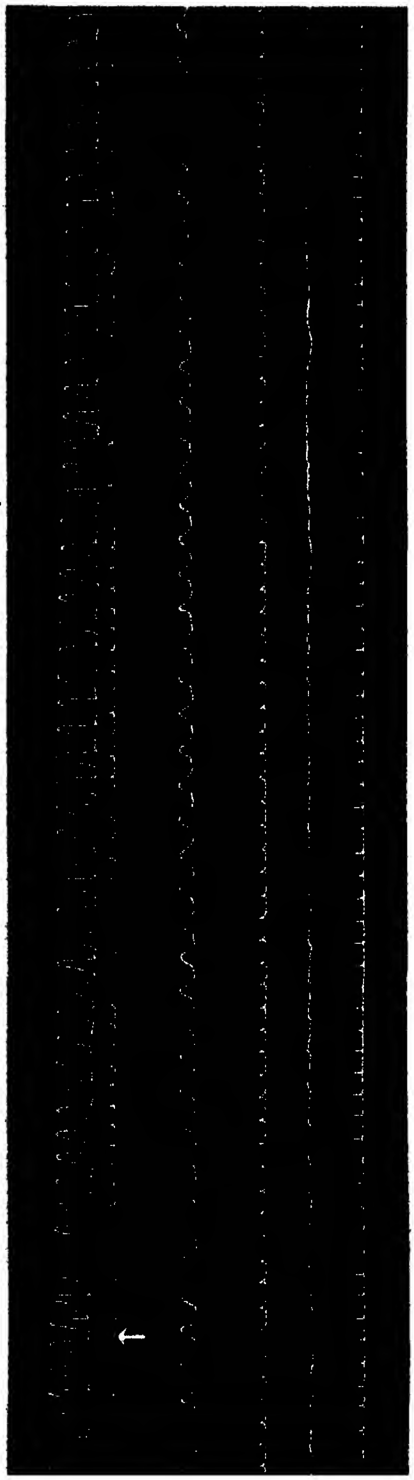
Exp. 4.—*Hyla caerulea,* weight 39 gms.

Effect of small dose on large frog.

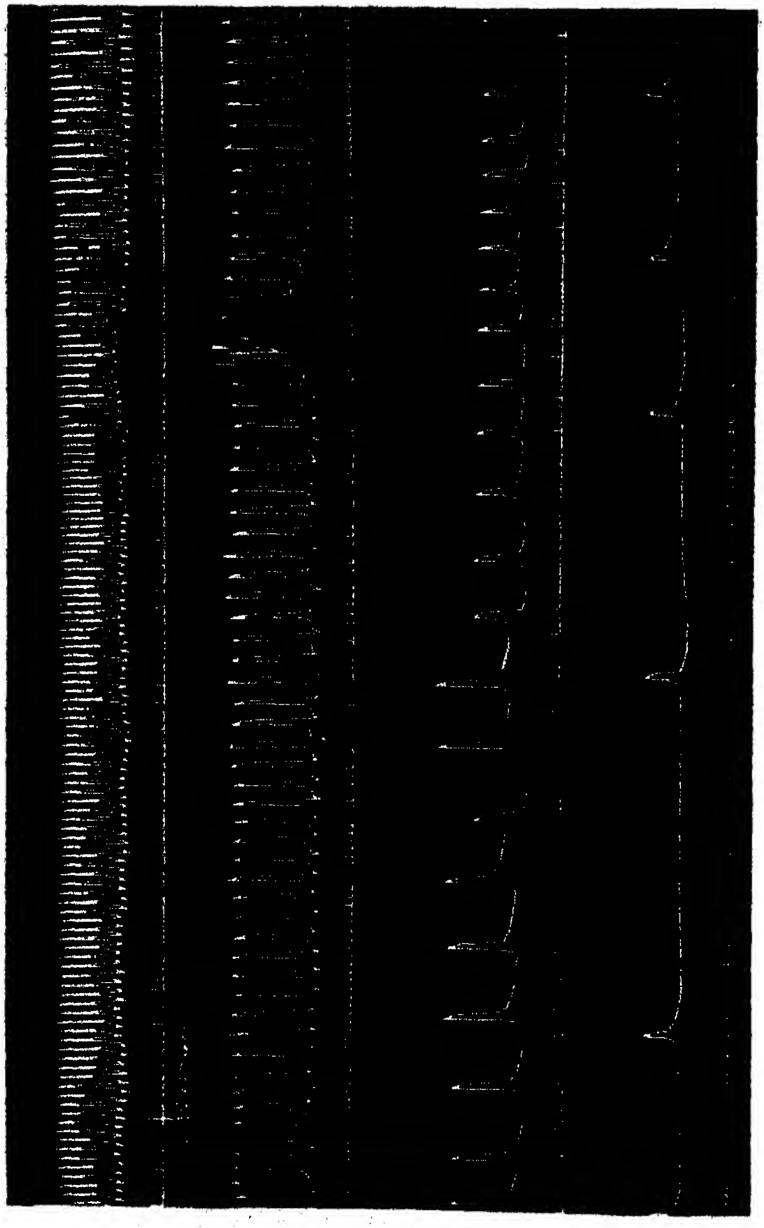
(*See diagram*).

Time	Heart beats	Observations.
	66	Normal heart. 1 drop alkaloid solution applied to heart.
after 1 min	63	
2 ,,	51	
4 ,,	63	
5 ,,	54	
6 ,,	57	1 drop alkaloid soln., 2nd. application.
7 ,,	51	
8 ,,	45	
10 ,,	30	
15 ,,	15	
20 ,,	9	Prolonged periods of stop in diastole.
29 ,,	1	Heart stopped in systole.
30 ,,	0	

Two drops of the 0.5% solution were applied in this case; the heart gradually beat slower and weaker, till it stopped with the ventricle in systole.



Exp. 2. The action of the Erythrophloeum alkaloid on frog's heart. (Top line, at start; second line, after 3 mins.; third line, after 7 mins.)



Exp. 4. Effect of 0.25 mgm. of alkaloid on frog's heart.

After the second application of alkaloid solution the rhythm of the heart changed. The systolic contractions were slightly increased. The beats were slower, and the continued widening of the curve, produced by the prolongation of the period of diastolic pause, was enormously drawn out near the end, till the final systolic contraction remained permanent.

In another experiment with the frog heart the number of beats decreased, and this was accompanied by an increase and lengthening of the diastolic phase. The ventricle remained full of blood when the heart had ceased to beat.

In the diagram, parts of this record are shown. The top line shows the commencement of the experiment, the second line after 10 minutes, the third line after 20 minutes, and the fourth line the end at 30 minutes.

(c) *Action on Dogs.*

The animals were anaesthetised by ether vapour. The blood pressure in the left carotid artery was recorded on the kymograph, and also the respirations by a stethograph drum fixed on the chest. The alkaloid, in the form of a saline solution of the hydrochloride, was injected from a burette into the right jugular vein. The concentration of this solution was equivalent to 1 milligram of alkaloid in each cubic centimetre of 0.9% physiological salt solution.

Exp. 5.—Dog, weight 3800 gms.

Time-interval	Blood-pressure	Respirations per min.	Heart-beats per min.	Observations.
	112 mms.	27	135	Normal records.
after				Ran in 2.5 mgs. of alkaloid during 16 secs.
20 secs.	184		150	Max. blood-pressure observed.
40 „	164			
60 „	176	26		
1 min. 40	132		81	Min. blood-pressure observed.
2 mins.	170	21		
3 „	176	22	140	
4 „	176	18		
5 „	176	14		
5½ „	176		140	
6 „	166	12	108	Blood-pressure began to fall.
7 „	156	14		
8 „	146	14	80	Heart-beats very irregular.
9 „		14		
10 „		11		
11 „		8		
12 „		6		
		0		

The time was reckoned from the completion of the injection.

The action of the alkaloid was almost instantaneous. 2.5 milligrams were injected, and before the last drop had entered the arterial pressure had risen considerably. The maximum pressure was reached 20 seconds after the end of the injection. The immediate result of the injection showed the blood-pressure

increased by 72 millimetres in 20 seconds and the rate of the heart beats increased by 15 per minute. The blood-pressure then fell and rose again, all within the first minute. After 1min. 40secs. the minimum point was reached where the blood-pressure dropped 52 millimetres below the maximum. It then rose, and remained high during 6 minutes, after which it began to fall, and continued till the end of the experiment.

The respirations decreased gradually from beginning to end. They had fallen to half the number in 6 minutes, and stopped at 12 minutes.

From the period of maximum blood-pressure, after 20 seconds the curve of respiration showed an ever increasing period of rest, or broadening out at the end of each inspiration.

In this experiment the intravenous injection of 0.0025 gram of alkaloid into a dog weighing 3800 grams proved fatal in 12 minutes. This amount is equivalent to 0.6 milligrams per kilogram of body-weight.

Exp. 6.—Dog, weight 2900 gms.

Time interval	Blood-press. in mms.		Respirations per min.	Observations.
	Mean	100	44	Normal records
after				Injected 1 mgm. alkaloid during 30 secs.
1 min.	"	135	47	
2 "	"	115	50	
4 "	"	135	50	Second injection, 1 mgm. alkaloid, 8 secs.
5 "			44	
6 "			40	
9 "	"	135	44	
10 "	Max.	156		Third injection, 3 mgms. alkaloid, 18 secs., heart-beats 228 per min.
11 "	"	180	40	
11½ "	"	160	17	Blood-pressure began to drop.
12 "	"	140	12	Heart-beats very irregular.
12½ "	"	30	7	
13 "	zero		0	Fibrillar twitchings observed.

After the intravenous injection of 1 mgm. of alkaloid an instantaneous rise was observed in the arterial blood-pressure, which reached its maximum after 1 min. and then fell. After a second injection of the same amount the pressure rose again to the same level and this time remained up. After 10 minutes a third injection of 3 milligrams was made. This time, although the mean pressure was unchanged, the maximum height rose 24 millimetres. One minute after the last injection the pressure began to fall and 2 minutes later the animal was dead. The respirations after the first small dose were increased in number, but after each subsequent injection no increase was observed. The depth of respirations in this experiment did not alter to any extent.

A post mortem examination showed the heart in diastole, but congested with blood on the right side only. The right ventricle was extremely dilated while the left was empty.

The liver, spleen, and intestines were very pale in colour, and peristaltic movements were very conspicuous.

Exp. 7.—Dog, weight 9450 gms.

Action on Respiration.

Observations.	Time	Number of respirations per min.
Normal curve shows.		60
Injected 0.5 mgm. into artery.	after	
Blood-pressure rose.	1 min.	71
	2 „	71
	4 „	71
	5 „	63
Second injection 1 mgm. into artery.		
Blood-pressure rose.	6 „	60
	10 „	71
	15 „	85
Third injection 1 mgm. into artery.		
Blood-pressure dropped.	16 „	95
	17 „	79
Blood-pressure rose again.	18 „	71
	19 „	31
Heart-beats very irregular.	23 „	23
Dog dead.	25 „	0

The arterial pressure curve showed a rise of blood-pressure immediately following the first and second injections, but not the third. The last injection was followed by a sudden drop, and after 1.5 minutes by a rise to a still higher level.

Summary of Results.

When very small doses of the alkaloid were administered to animals, in these experiments, a complete change was observed in the heart-rhythm and respirations.

Blood-pressure.—During the few seconds required to run in the solution, the blood-pressure rose, and quickly reached a maximum. This was soon followed by a drop, which, however, never reached the previous normal level but rapidly rose again and remained high till near the end when it rapidly fell to zero.

Heart-beats.—In one frog alone the heart-beats were accelerated; in the other frogs the number was decreased. The dog in experiment 5 showed a large increase after the injection.

Respiration.—In experiment 5 after an injection of 2.5 milligrams the number of respirations gradually decreased during the 12 minutes, from 27 to 0 per minute. In No. 6 experiment 1 milligram injected produced an increase in number, but after a second and third injection the number gradually lessened, and ceased after 13 minutes. In No. 7 experiment 0.5 milligram accelerated the respirations, and after a second and third injection still further accelerations were observed. One minute after the last, the number decreased, and 7 minutes later the respiration ceased.

The chief characteristic of the drug is, therefore, its action on the heart-muscle. The tone is increased, heart relaxes less during diastole, and in the later stages the heart-beats become very irregular. The heart in most cases comes to a standstill in systole.

Convulsive movements were observed in the animals towards the end of the experiments.

The general result of these experiments would refer the alkaloid to the digitalis group in its pharmacological action.

DISCUSSION OF RESULTS.

The alkaloids of E. Laboucherii *and* E. guineense *compared.*

(*a*) Chemical Properties.

The alkaloid of the Australian species closely resembles the description of Merck's pure erythrophleine. Both alkaloids and all their salts were uncrystallisable syrups. The hydrochloride, prepared under the most careful conditions, was obtained as a viscous yellow oil, which dried into a brown solid glutinous mass: in this respect it resembled the product of Merck, and of Power and Salway.

Harnack's provisional formula for erythrophleine, $C_{28}H_{43}O_7N$, was obtained from the amorphous platinum salt, and represents a molecular weight of 505.

Power and Salway obtained an approximate agreement of the above formula from the analysis of the hydrochloride, which they prepared from a sample of Merck's erythrophleine. This hydrochloride salt yielded to the authors (6.9% Cl) 7.1% HCl and corresponds to the formula B.HCl (B=1 molecule of Base).

The alkaloid from the Australian species, on the other hand, when titrated with the greatest care gave 3.64% of hydrochloric acid, just half the amount obtained by Power and Salway. This amount, however, corresponds to the formula $[B]_2$ .HCl.

$[C_{28}\ H_{43}\ O_7\ N]$ .HCl requires 7.21% HCl.

$[C_{28}\ H_{43}\ O_7\ N]_2$ .HCl „ 3.61% HCl.

Accepting the latter as the formula of the hydrochloride obtained from the Australian *Erythrophloeum*, the agreement in the molecular weight thus found is so close as to justify the conclusion that the alkaloid is identical with the erythrophleine of the African species.

(*b*) Physiological Properties.

The violent effects produced on the respiratory organs by this plant, during the grinding and preparing of the sample for analysis, were also experienced and noted by all the investigators of *E. guineense*.

In the examination of a pharmacologically active plant, the collective effects produced in the animal body by the active principle are referred to certain types or groups of substances. In this way we observe the action of the atropine group, the curare, or, the digitalis group. The action of the digitalis group is recognised chiefly by a special action on the cardiac muscle, with which there is a strengthening of the systolic phase of the heart and finally complete stopping of the ventricle in systole.

The substances which produce these effects are certain organic compounds, mostly glucosides, which have been obtained from plants, and include digitalis, apocynin, antiarin, convallamarin, helleborein, oleandrin, scillain and some of the African arrow-poisons.

The general action of the digitalis group as indicated above, was observed in all the experiments on frogs and dogs carried out with the alkaloid of *Erythrophloeum Laboucherii.*

The pharmacological properties were compared with those of *E. guineense* in the literature quoted, being the investigations of Lauder Brunton, Harnack, Merck, and Dr. Dale of the Wellcome Research Laboratories. The alkaloids of the two species of *Erythrophloeum* have the same action: that is, the active principle of the Australian *E. Laboucherii* is the alkaloid erythrophleine.

It is remarkable that a group of properties hitherto known to belong only to certain glucosides should also be exhibited by an alkaloid.

The red colouring substances.

Luteolin is a flavone derivative, one of a group of yellow dyes produced in the metabolism of plants. It has been identified in Dyer's weed (*Reseda luteola*), *Digitalis purpurea, Genista tinctoria* and *Erythrophloeum guineense.* It exists in three states:—as free luteolin, as methyl esters, and as glucosides of both of these. It is closely related to the quercetin dyes, including Mr. H. G. Smith's myrticolorin, obtained from the leaves of the Eucalyptus. Luteolin is isomeric with fisetin and lotoflavin, also yellow dyes. The latter constitutes one of the groups, with sugar and hydrocyanic acid, forming lotusin, the cyanogenetic glucoside of the lotus plants (*Lotus arabicus, L. australis, L. corniculatus,* etc.). All these flavone derivatives are built round the important pyrone ring, and by the number and position of their hydroxy groups their tinctorial properties are determined, and the various members are identified. Luteolin is a tetrahydroxy flavone.

A most prominent feature throughout this investigation was the deep red colour of the solutions. There is no doubt that this red colouring matter is closely connected with the characteristic colour of the wood, as myrticolorin is with the red stringybark (*Eucalyptus macrorhyncha*).

These flavone glucosides are important metabolic products of the plant tissues, and possess an astringent and very bitter taste. The intensely bitter taste of the original extract of the leaves of *E. Laboucherii* was doubtless in part due to this cause.

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EXPLANATION OF PLATES XXIII.-XXIV.

Plate xxiii.

Erythrophloeum Laboucherii, leaves and fruit.

Plate xxiv.

Erythrophloeum Laboucherii.

Fig. 1. Close view showing characteristic bark.
Fig. 2. Tree growing in Northern Territory.

SPECIAL GENERAL MEETING.

31st August, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Business. To consider the Council's recommendation that a new set of Rules, numbered i. to lviii., replace the existing Rules.

It was unanimously resolved, on the motion of Mr. J. H. Campbell, seconded by Mr. A. F. Basset Hull, that the draft rules submitted, a printed copy of which had been forwarded to each member, be adopted as the Rules of the Society in accordance with the Society's Act of Incorporation.

ORDINARY MONTHLY MEETING.

31st August, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Mr. Alexander N. Burns, Roslyn, Salisbury Road, Rose Bay, was elected an Ordinary Member of the Society.

The Donations and Exchanges received since the previous monthly meeting (27th July, 1921), amounting to 28 Vols., 135 Parts or Nos., 12 Bulletins, 9 Reports and 1 Pamphlet, received from 65 Societies and Institutions and two private donors were laid upon the table.

NOTES AND EXHIBITS.

Mr. W. F. Blakely exhibited from the National Herbarium two exotic Caryophyllaceous plants new for the State. (1) *Saponaria Calabrica* Guss., from the hill opposite Cave House, Jenolan Caves (W. F. Blakely, Oct., 1899), Mr. J. Wilson, who for a number of years was proprietor of the Cave House, expressed the opinion that it was introduced in foreign chaff that he brought to the Caves. (2) *Silene noctiflora* L. "Night Silene or Clammy Cockle." Ulong near Coramba (W. Heron, Feb., 1913). This plant is said to be a native of Sweden and Germany, but it is now a cosmopolitan weed. In various parts of the United States it is a pest in agricultural areas, and its seeds sometimes form one of the impurities of Lucerne seed.

Mr. E. Le G. Troughton exhibited, with the permission of the Director of the Australian Museum, a very remarkable skull of *Bettongia cuniculus*, a Rat-Kangaroo, showing features of the cheek-teeth which are characteristic of the young animal on one side and of the adult on the other. In the young dentition, which is on the right side, the two premolars are present but are followed by five molars instead of only three as is normal at this stage. The dentition on the left side is typical of the adult, exhibiting the enlarged fourth premolar which takes the place of the two milk-premolars, while only four molars are present.

Also a specimen of the yellow-footed Pouched Mouse, *Phascogale flavipes*, accompanied by photographs, taken by Mr. A. Musgrave, of a nest of the species and its location. The specimen and photographs were taken at National Park, N.S.W.

Mr. N. B. Friend exhibited the fangs and dried venom taken from a Diamond Rattler Snake (*Crotalus adamanteus*) at Taronga Park. This species gives a very large quantity of venom at one injection. The amount of dried venom obtained was 0.5 gram and corresponds to about 30 lethal doses for a rabbit.

Mr. E. Cheel exhibited a series of specimens of the Rai or Indian Mustard (*Brassica juncea* Cass.), showing the early seedling stage, together with the flowering and seedling plants cultivated at Ashfield from plants which he found naturalised in the Rarawai District, Fiji, in July, 1918. He also exhibited two forms of "Colza Rape" (*B. campestris*) received from Mr. A. Willis, said to have come from the North Coast District of this State. Samples of the original seeds exhibited showed two distinct kinds, which, when selected and grown separately, produced plants very much alike in general character, but the capsules of one kind are shorter and thicker, and the plants somewhat glaucous, and the seeds of some of the resultant plants are of a pale brown, or in some cases light yellow or white colour. Some pale yellow seeds separated from the original sample and grown separately proved to be indistinguishable from the "White Mustard" (*B. alba*). Samples of "Field Rape" (*B. napus*) and "Black Mustard" (*B. nigra*) seeds were also exhibited for comparison. Specimens of the "Rock Salad" (*Eruca sativa* Mill) were also exhibited, raised from impurities obtained from Linseed received from Mr. A. Willis. The latter species is naturalised in several parts of this State, and in South Australia.

Mr. E. Cheel also exhibited fresh specimens of three interesting orchids, viz.: *Pterostylis barbata* (very rare in the Port Jackson District) *Caladenia tesselata*, also comparatively rare, and *Lyperanthus nigricans*, all collected at Little Bay by Mr. H. L. Duckworth. It is interesting to note that the area where *Lyperanthus nigricans* was collected had been overrun by a bush-fire during last season.

DESCRIPTIONS OF NEW SPECIES OF AUSTRALIAN *COLEOPTERA*.

Part xvii.

By Arthur M. Lea, F.E.S.

(One Text-figure.)

NITIDULIDAE.

Cychramus fimbriatus, n. sp.

♂. Dull castaneous-brown, parts of appendages somewhat paler, club infuscated. Moderately clothed with short, depressed ashen pubescence, interspersed with longer, subdepressed and somewhat reddish hairs; a conspicuous fringe on each side.

Head with dense and sharply-defined but rather small punctures, becoming still smaller on clypeus; labrum deeply incised. Antennae with third joint elongate, club almost circular. *Prothorax* evenly convex, base about thrice as wide as the median length, sides strongly rounded and very feebly margined, hind angles rounded off, apex about half the width of base, deeply emarginate, the emargination straight across middle, oblique on sides; punctures much as on head. *Elytra,* when at rest, with outlines continuous with those of prothorax, scarcely longer than the basal width, sides evenly diminishing to apex; punctures as on prothorax, non-striated. Intercoxal process of *prosternum* truncated posteriorly, middle and hind coxae widely separated. Fifth segment of *abdomen* notched at apex, and with a small conical process there, sixth segment small, circular, and slightly concave. *Legs* stout, three basal joints of front and middle tarsi wide, of the hind tarsi rather thin. Length, 6.25 mm.

Hab.—Queensland: Cairns (E. Allen), unique.

The marginal fringe is dense and even on each side from apex of prothorax to apex of elytra, but gradually decreases in length from apex to base of prothorax and from base to apex of elytra, it is continued, but more irregularly and with longer hairs to tip of abdomen; it causes the species to be the widest in proportion of all Australian *Nitidulidae* known to me. On the type, portion of the propygidium is exposed.

MALACODERMIDAE.

Metriorrhynchus hexastichus, n. sp.

♂. Sooty-brown; sides of prothorax, and sides and tips of elytra flavous.

Head with very short muzzle. Antennae long and rather thin, moderately

serrated, all the joints (after the very small second one) longer than wide, third slightly longer than fourth, eleventh about one-fourth longer than tenth. *Prothorax* almost as long as the apical width, five-areolate, apex obtusely produced in middle, front angles almost rectangular, hind ones produced and acute. *Elytra* slightly wider near apex than at base; with single rows of large and mostly quadrangular punctures, but becoming double on sides and base. Length, 5.5 mm.

Hab.—New South Wales: Blue Mountains (Dr. E. W. Ferguson); unique.

The dark parts of the type are of a dingy sooty-brown, but probably on fresh specimens would be black; the flavous parts of the elytra are slightly dilated on the shoulders and tips, and continued for a short distance on the suture near apex; the legs and antennae are so thin as to appear semi-transparent. The median areolet of the prothorax is narrow at base, of moderate width in middle, and continued almost to apex; an oblique and moderately sharp costa connects it with the middle of each side. The punctures, except close to the base, are in six rows on each elytron, not in five, as is usual when they are in single series, as the lateral row is doubled throughout its length; at the base there are eight rows on each, owing to the humeral thickening preventing the doubling of the third and fourth series. The elytral punctures in single series on most of the surface, and the bicoloured and five-areolate prothorax, readily distinguish the species from all previously described ones.

METRIORRHYNCHUS SCULPTICOLLIS, n. sp.

♂. Black and brick-red verging to flavous.

Head with rostrum rather long (about two-thirds the length of prothorax). Antennae rather long and thin, third joint fully thrice as long as wide, fourth about one-third shorter than third, and slightly longer than fifth, the others to tenth gradually decreasing in length but becoming more strongly serrated, eleventh about one-third longer than tenth. *Prothorax* slightly longer than the apical width; conspicuously seven-areolate; apex subtriangularly produced but truncated in middle, sides subparallel on apical half, then dilated and elevated to base, with the hind angles rounded off. *Elytra* almost parallel-sided; with regular double rows of punctures, the alternate interstices moderately elevated. *Femora* with some moderately long hairs; tibiae rather wide. Length, 8-10.5 mm.

Hab.—Queensland: Cairns (E. Allen).

The pale parts are the prothorax, scutellum, elytra, two spots at base of rostrum, and parts of three or four basal joints of antennae; on the type most of the front femora and less of the middle ones are pale, on a second specimen the legs are almost entirely black. Seen from behind the median areolet, at its widest part, appears to have two short costae, connecting it with one which touches the middle of the apex; so that the three form a long-stemmed Y, but from in front the short arms of the Y do not appear to quite touch the marginal costae of the areolet at its widest, consequently, although seven areolets are distinct, the medio-basal one, and two medio-apical ones, do not appear to be completely isolated from each other, although distinctly separated from the lateral ones. In general appearance it is close to *M. elongatus*, *M. uniformis*, *M. textilis*, *M. nigripes* and *M. rufirostris*, from all of which it is distinguished by the rostrum, this being decidedly longer than in *elongatus* and *rufirostris*, and shorter than in the others; its base is also bimaculate. The front of the prothorax is also distinctive: on both specimens the front half of each of the four frontal

areolets is occupied by numerous transverse or oblique subcostal elevations, due to narrow striae, and not rising to the level of the costae margining the areolets.

METRIORRHYNCHUS RUFICOLLIS, n. sp.

♂. Black; prothorax, scutellum, and base of elytra brick-red.

Head without rostrum. Antennae moderately long, third to tenth joints ramose, eleventh more than twice the length of the non-ramose portion of tenth. *Prothorax* moderately transverse; conspicuously seven-areolate; apex subtriangularly produced in middle, front angles rounded off, hind ones produced and acute. *Elytra* almost parallel-sided; with double rows of somewhat irregular punctures, the alternate interstices conspicuously elevated. Length (♂, ♀), 7-7.5 mm.

♀. Differs in having the antennae shorter, wider and strongly serrated, apex of prothorax less produced, abdomen wider, subapical segment not notched, and legs somewhat shorter.

Hab.—Queensland: Cairns and Little Mulgrave River (H. Hacker).

On the type, the pale portion of the elytra is longest on the shoulders, where it is about twice the length of the scutellum, but it is not the length of the scutellum near that organ; on the female it occupies rather more than the basal fourth; a second female is evidently somewhat discoloured, its pale parts being of a rather dingy flavous, but they cover the same area as on the other; the ramus of the third joint of the male is about half as long again as its supporting joint; on the following joints it increases in length to the seventh, when it decreases to the tenth, the ramus on that one being no longer than its supporting joint. From some directions the elytral punctures at first appear to be in single series, but on closer examination connecting longitudinal lines are quite distinct. In my table (Trans. Ent. Soc. Lond., 1909, p. 51) it would be placed with *M. longicornis* and *M. costicollis*; from the former it is distinguished by the ramose antennae of the male, and from the latter by the very different elytral punctures, and by each elytron having four conspicuous discal costae throughout.

METRIORRHYNCHUS LATERARIUS, n. sp.

♂. Prothorax, scutellum and elytra brick-red; trochanters obscurely pale, elsewhere black.

Head with very short rostrum. Antennae with third to tenth joints ramose, eleventh twice the length of non-ramose part of tenth. *Prothorax* moderately transverse; conspicuously seven-areolate; apex obtusely produced in middle, front angles obtuse, hind ones slightly acute. *Elytra* narrow; with regular double rows of punctures, the alternate interstices moderately elevated. Length, 7-7.5 mm.

Hab.—Queensland: Cairns (E. Allen).

In my table would be placed with *M. miniatus*, which has the prothorax considerably wider, with the median areolet longer and the front ones much less sharply defined; structurally it is rather close to *M. gracilis*, but with elytra entirely pale, and thickened front margin of prothorax not semidouble; from the specimens of *M. apicivarius*, with entirely pale elytra, it differs in the antennal rami being much shorter, and normally pubescent, instead of hairy; the ramus of the third joint is scarcely longer than its support, that of the tenth joint is no longer, and on not one of the intervening joints is it twice as long as its support.

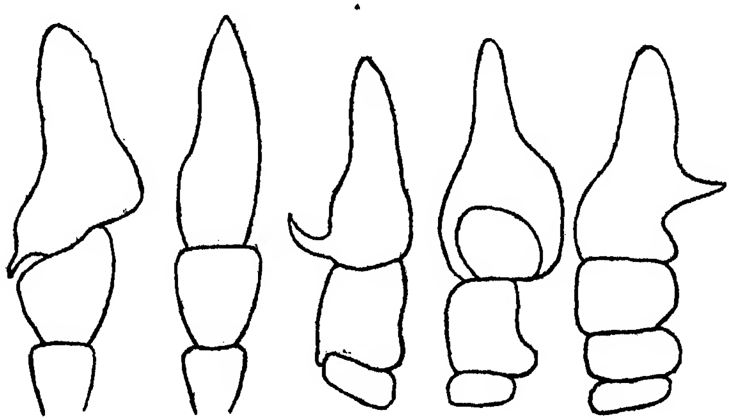
HETEROMASTIX OBSCURUS, n. sp. (Text-figs. A, B.)

♂. Dark chocolate brown, some parts black, parts of legs obscurely paler. Clothed with ashen pubescence.

Head rather large; eyes small. Antennae stout, first joint about twice the length of second but scarcely longer than third, fourth to ninth each slightly longer than wide, tenth and eleventh irregular. *Prothorax* almost twice as wide as long; margined throughout. *Elytra* almost parallel-sided throughout; with dense and minute, but usually sharply defined punctures. Subapical segment of *abdomen* deeply incised. Length, 6 mm.

Hab.—New South Wales: Forbes, unique (H. J. Carter from A. Stephens).

A fairly wide species, readily distinguished from all others with terminal joints of antennae distorted, by its almost uniformly dark-brown colour; the antennae are somewhat thicker than in *H. gagaticeps*, and *H. flavifrons*, and the terminal joints are of different shape. The tenth joint is somewhat wider than the ninth and longer on one side than on the other, the eleventh is about as long as the ninth and tenth combined, produced into a short process at the base on to the shorter side of the tenth, and constricted near the middle.



A B C D E

A.B. Terminal joints of antennae of *Heteromastix obscurus*.
C.D.E. ,, ,, ,, *H. mirus*.

HETEROMASTIX MIRUS, n. sp. (Text-figs. C, D, E.)

♂. Black; muzzle, prothorax, legs (parts of hind and of middle femora infuscated), and antennae (four or five median joints slightly infuscated) flavous. With short, ashen pubescence.

Head obliquely flattened or very gently convex in front, with two feeble inter-ocular impressions. Antennae moderately long, first joint as long as second and third combined, second more than half the length of third, sixth to ninth transverse and slightly produced on one side, tenth and eleventh distorted. *Prothorax* almost twice as wide as long, sides dilated and slightly thickened near apex. *Elytra* parallel-sided to near apex; with dense and fine, subrugulose punctures. Length, 3.5 mm.

Hab.—Queensland: Coen River (H. Hacker's No. 536).

The eleventh joint of antennae near the base has a strong curved spine marking the end of a large excavation; the tenth joint is longer than the ninth and eighth combined, and also has a large hollow; on one side of the base it is produced so as to embrace the ninth feebly; from some directions it appears as two conspicuous joints, and the antennae in consequence appear to be twelve-jointed; from other directions the eleventh also appears to be obliquely divided into two joints; in fact the two apical joints alter in appearance with every point of view. *H. bicolor* has all the joints thinner, and the ninth to eleventh very different.

HETEROMASTIX CRIBRIPENNIS, n. sp.

♂. Black; tips of elytra, part of under surface of muzzle, and trochanters obscurely pale. With moderately dense, ashen pubescence.

Head with vague inter-ocular impressions; with fairly distinct punctures in front, but not sharply defined. Antennae long and thin, second joint not half the length of third, sixth and seventh each about the length of eleventh, and slightly longer than the intervening ones. *Prothorax* fully twice as wide as long, margined throughout, sides strongly rounded in front and slightly narrower there than at base; with submarginal punctures. *Elytra* thin, slightly wider near apex than at base; with crowded and comparatively large, sharply defined punctures. Subapical segment of *abdomen* deeply notched. *Legs* long and thin. Length (♂, ♀), 4.5—5 mm.

♀. Differs in having the head smaller, with less prominent eyes, legs and antennae shorter, and subapical segment of abdomen straight at apex.

Hab.—Tasmania: Waratah, Burnie (A. M. Lea).

Close to *H. tenuis*, but elytra without purplish gloss, and (on four specimens) tipped with obscure flavous, the sides near base of prothorax hardly notched (there is a feeble incurvature there, but on the male of *tenuis* there is a small triangular notch); the pubescence of the elytra is denser, shorter and paler, the antennae are thinner, and the abdominal notch of the male is much longer; from *H. niger* it is still more distinct. In my table (*l.c.*, p. 181) it would be placed with *H. dolichocephalus*, to which it is not at all close. On one male the abdomen and femora are obscurely paler than the adjacent parts. A male variety from Southport has a flavous, almost white, vitta from base to apex of each elytron, near the side, but dilated so as to cover the entire apex for a short distance.

HETEROMASTIX MEGALOPS, n. sp.

♂. Prothorax, scutellum and legs flavous, elsewhere more or less deeply infuscated. With short, ashen pubescence.

Head large, gently concave in front. Eyes unusually large and prominent. Antennae long and thin, extending almost to tips of elytra. *Prothorax* more than twice as wide as long, base and apex finely margined; sides suddenly and strongly dilated, or obtusely dentate, slightly nearer apex than base. *Elytra* parallel-sided to near apex; with dense, and fine, rugulose punctures. Length (♂, ♀), 2.75-3 mm.

♀. Differs in having the head smaller, eyes smaller (but still of large size), antennae much shorter, and in the abdomen.

Hab.—Queensland: Cairns (E. Allen).

The elytra of the type could not be regarded as black, they are of a dark smoky-brown, similar in shade to most of the under surface (the tip of the

abdomen is paler); the head is moderately infuscated on the basal half and paler in front, but the shades of colour are not sharply defined; the antennae are almost uniformly infuscated throughout. One female has the head uniformly infuscated, but otherwise its colours are as those of the type; a second female has the head entirely pale, and elytra much less deeply infuscated. Regarding the head as pale the species, in my table, would be associated with *H. anticus* and *H. geniculatus*, which have sides of prothorax very different and much smaller eyes; regarding the head as dark it would go with the allies of *H. pusillus*, from all of which it is at once distinguished by the very large eyes; thus on the male of *H. pusillus* the combined width of both eyes is less than half the width of the intervening space, on the present species each eye is more than half the width of that space, and its length is about equal to the combined lengths of the second and third joints of antennae; the sides of the prothorax are much as in *H. denticollis* and *H. angustus*, whose eyes are much smaller.

HYPATTALUS CRIBRIPENNIS, n. sp.

♂. Black; labrum, prothorax, parts of under surface of three basal joints of antennae, and trochanters flavous. Moderately clothed with short, erect, dark hairs, and with sparse, ashen pubescence.

Head gently convex, slightly depressed in front. Antennae rather long, third to tenth joints obtusely serrated, seventh joint slightly longer than the adjacent ones, and about equal to eleventh. *Prothorax* widely transverse, sides widely rounded and with the base obliquely margined, a shallow depression near base, and a still more feeble one near apex; with a few scattered punctures. *Elytra* parallel-sided to near apex, sides and suture slightly thickened, the apex more distinctly so; with crowded, sharply defined punctures, a few of which are confluent. *Legs* moderately long. Length (♂, ♀), 5-5.75 mm.

♀. Differs in having the head smaller, with two feeble foveae in front, eyes smaller and less prominent, antennae shorter and less strongly serrated, apical joint of palpi smaller, apex of elytra scarcely thickened, legs somewhat shorter, and clothing of upper surface sparser.

Hab.—Tasmania: Waratah (A. M. Lea).

At first glance much like many species of *Heteromastix* but with exsertile vesicles. In my table (*l.c.*, p. 169) would be placed with *H. abdominalis*, which is a much smaller species, with blue elytra, etc.; *H. longicornis* has bluish elytra and much longer and less strongly serrated antennae; the female in general appearance is somewhat like a large female of *H. trianguliferus*, but the antennae are less strongly serrated, and more of the head is dark. A female, from Mount Wellington, probably belongs to this species, but has the frontal foveae more conspicuous, and elytra with a faint purplish gloss.

HYPATTALUS APICIVENTRIS, n. sp.

♂. Black; muzzle, parts of four or five basal joints of antennae, basal joints of palpi, prothorax, and base of femora flavous. With sparse and minute, ashen pubescence.

Head moderately convex between eyes, slightly irregularly concave in front; with small, scattered punctures, becoming denser at base. Antennae moderately long and feebly serrated, second joint small, third and fourth not much larger. *Prothorax* strongly transverse, base finely margined, basal half

of sides more widely so; with a few scattered punctures. *Elytra* parallel-sided to near apex, sides and suture scarcely thickened; with dense and sharply defined, but somewhat rugose punctures. Apical segment of *abdomen* rather large. Hind *tibiae* rather thin and strongly curved. Length, 4-4.5 mm.

Hab.—Tasmania: Waratah (A. M. Lea).

Close to the preceding species, but antennae shorter and less serrated, more of muzzle and of legs pale, elytra with much sparser clothing, and with sparser, although dense, punctures. The elytra have a faint bluish gloss, and their sides in the middle are very narrowly and obscurely flavous. The apical segment of the abdomen is large and less liable to contraction than the others, as it is gently convex and without wrinkles on the three specimens before me, its dorsal and ventral sclerites meet at the tip, and, from the sides, a passage may be seen through them.

HYPATTALUS FLAVIPES, n. sp.

♂. Black; prothorax and legs flavous, parts of tarsi infuscated. With short, ashen pubescence.

Head feebly convex between eyes, with two shallow depressions in front; with small and sparse punctures, becoming denser about base. Antennae moderately long, thin and feebly serrated. *Prothorax* strongly transverse, sides and base finely margined; with sparse, inconspicuous punctures. *Elytra* parallel-sided to near apex, sides and suture scarcely thickened; with crowded, sharply defined punctures. Hind *tibiae* rather strongly curved. Length, 3 mm.

Hab.—New South Wales: National Park (A. M. Lea).

Like *H. longicornis* on a small scale, but upper surface almost glabrous, elytral punctures more sharply defined, legs flavous and antennae somewhat shorter; in my table it would be placed with *H. abdominalis,* but is thinner, differently coloured, antennae much longer and elytral punctures larger. Parts of the basal joints of antennae are obscurely flavous or testaceous, and the space between the eyes is obscurely diluted with red.

HYPATTALUS PARVONIGER, n. sp.

♀. Black; trochanters, most of front legs, parts of the others and parts of four or five basal joints of antennae flavous or testaceous. Upper surface with sparse and extremely short, ashen pubescence.

Head with two shallow depressions in front; punctures sparse and minute. Antennae moderately long and obtusely serrated, eleventh joint about twice the length of tenth. *Prothorax* rather strongly transverse, sides and base finely margined, a shallow depression each side of base; punctures minute on sides, not traceable elsewhere. *Elytra* slightly dilated to near apex, sides and suture scarcely thickened, with small rugulose punctures. *Legs* thin, the hind tibiae moderately long. Length, 1.5 mm.

Hab.—New South Wales: Sydney (G. E. Bryant), Eden (H. J. Carter).

Smaller than any other known species, except *H. minutus,* and upper surface entirely black (in some lights the elytra have a vague purplish gloss); from *H. carteri* it differs in being smaller, elytra darker and non-metallic, legs partly pale, and upper surface almost glabrous. There are fairly numerous punctures on the elytra, and they are sufficiently distinct from oblique directions, but they are nowhere dense and sharply defined.

CARPHURUS SPINIPENNIS, n. sp.

♂. Flavous; mesosternum, metasternum, base (but not sides) of several segments of abdomen, and parts of coxae and of femora black; apical half of antennae and parts of tarsi infuscated. With long, dark hairs, and in parts with sparse, white pubescence.

Head with a wide and fairly deep impression in middle; between it and eyes with dense and sharply defined punctures; base transversely strigose. Antennae moderately long, third to fifth joints rather wide, the others gradually decreasing in width. *Prothorax* slightly longer than its greatest width, a wide shallow depression near base; a few punctures scattered about. *Elytra* about twice the length of prothorax, each side near apex with a conspicuous notch, its posterior end with a rather long acute spine, directed forwards and outwards; with fairly dense but not very sharply defined punctures. Basal joint of front *tarsi* with a small, black, inner comb. Length, 4.5 mm.

Hab.—Queensland: Dalby (Mrs. F. H. Hobler), unique.

The armature of the elytra is much as in *C. cristatifrons* and *C. gallinaceus*, but the surface near it is not thickened, and the head is not crested; in *C. pisoniae* the head is bimaculate, and very differently sculptured, the elytral punctures are much stronger, and the side of each elytron before the spine is abruptly pointed, in the present species the side is gently curved to the spine.

CARPHURUS NIGROFASCIATUS, n. sp.

♂. Black and flavous. With moderately long, dark hairs, scattered about, and in parts with sparse, whitish pubescence.

Head gently convex between eyes; with a large, obtuse, inter-antennary elevation, its posterior end bounded by a narrow groove; with dense and small punctures, the extreme base transversely strigose. Antennae moderately long, second joint distinctly transverse, the whole of its inner side slightly produced. *Prothorax* about once and one-third as long as wide, apex not much wider than base, a large shallow depression near base; with dense and small punctures on sides, much sparser elsewhere. *Elytra* slightly dilated to beyond the middle, at apex widely separately rounded; with numerous small, and rather sharply defined, but sub-asperate punctures. Basal joint of front *tarsi* lopsided, with a black inner comb. Length, 4 mm.

Hab.—Queensland: Dalby (Mrs. F. H. Hobler), unique.

At first glance the type appears to be a variety of *C. elongatus*, but the sculpture of the head and the dilated second joint of antennae are at once distinctive. In my table (*l.c.*, p. 188) it could not be referred to *ggg* as the elytra have less than half of their surface black, but the markings are as sharp as in *C. elongatus*. The paler parts are rather dingy and vary from flavous to reddish-flavous; they are the head (except for a large subtriangular black spot at the base), prothorax (except for a black spot extending from the apex to the middle on each side), elytra (except for a black fascia near the apex, the fascia covering about one-fourth of their length), parts of two apical segments of abdomen, four basal joints of antennae, and most of legs.

CARPHURUS COLLARIS, n. sp.

♀. Black, with a slight bluish gloss; elytra metallic violet-blue, prothorax, tibiae and most of basal joint of antennae flavous. With rather sparse, dark hairs, and in places very sparse, whitish pubescence.

Head with a vague, curved depression, with irregularly distributed punctures. Antennae rather short, third to tenth joints strongly serrated. *Prothorax* about as long as the greatest width (almost across exact middle), angles rounded off, base no narrower than apex, a very shallow depression near base, with a few scattered punctures. *Elytra* about thrice the length of prothorax, with dense, rugose punctures. Length, 4.5 mm.

Hab.—Western Australia: Mullewa (Miss J. F. May), unique.

The elytral punctures, although of fairly large size, are so rugose that very few are sharply defined. At first glance the species seems close to *C. bifoveatus*, but the elytra are of a brighter and more metallic blue, and with the punctures more coarsely rugose; there are also differences of colour in the abdomen and legs. In my table it would be placed with *C. rhagonychinus*, *C. simulator*, and part of *C. variipennis*, but *rhagonychinus* is now known to be a *Balanophorus*, which the present species certainly is not, as its front tarsi are combless, and they are comb-bearing in both sexes of that genus; the other species are very differently coloured and punctured.

Carphurus opacipennis, n. sp.

♂. Of a dingy flavous; tip of eleventh joint of antennae, a rather large spot on each elytron, mesosternum, metasternum, parts of under surface of four basal segments of abdomen, and hind coxae infuscated or black. With very short, whitish pubescence; a few long hairs scattered about, but not on prothorax and elytra.

Head rather long, gently convex between eyes, somewhat uneven in front; with minute punctures, becoming more distinct behind eyes; base transversely strigose. Antennae long and thin, very feebly serrated. *Prothorax* distinctly longer than wide; sides strongly rounded and widest at apical third, a shallow depression near base; punctures inconspicuous. *Elytra* opaque, about twice the length of prothorax, with crowded but sharply defined punctures. Basal *joint* of front *tarsi* large, lopsided, with a narrow black comb on inner edge from near base to apex, around which it curves. Length, 6.5 mm.

Hab.—Queensland: Claudie River (Jas. A. Kershaw). Type (unique) in National Museum.

The elytra are of a darker shade of colour than the other parts, the large spot on each is somewhat rounded, nearer the side than the suture, and at about the apical third; the shoulders are also slightly infuscated; their opaque surface, with dense punctures, causing the surface to appear finely granulated or shagreened, render the species a very distinct one. In my table it would be associated with *C. frenchi*, with which it has few details in common.

Helcogaster obliquiceps Lea.

A male of this species, from Jenolan (New South Wales) differs from the type in having the head almost entirely dark, the muzzle being, at most, obscurely diluted with red on the sides; the dark parts are also more intensely black than on the type.

Helcogaster maculiceps Lea.

A male of this species in Mr. H. J. Carter's collection, from Illawarra, has a small black spot on the disc of the prothorax, five of the abdominal segments black except at the tips and sides, and all the femora black on the basal half.

HELCOGASTER BASIRUFUS Lea.

Three females, from Geraldton (Western Australia) evidently belong to this species, they differ from the male in having more of the head dark, and without conspicuous ridges and excavations, the prothorax is not notched in front, and the black mark is reduced to a small longitudinal spot; the front tarsi are also simple.

HELCOGASTER RHYTICEPHALUS Lea.

A female of this species, from Narara (New South Wales) in Dr. Ferguson's collection, has an elongate-oblong black spot on the disc of the pronotum.

HELCOGASTER NIGRIVENTRIS, n. sp.

♂. Flavous; mesosternum, metasternum, abdomen, coxae and parts of hind femora black; parts of antennae infuscated. With sparse, dark hairs.

Head with a rather shallow impression each side in front. Antennae rather short and wide, second-tenth joints obtusely serrated. *Prothorax* moderately transverse, deeply transversely impressed near apex, middle of apex notched, with a small elevation each side of the notch, hind margin of impression irregular; a shallow depression near base. *Elytra* distinctly longer than wide; with sparse, inconspicuous punctures. Basal joint of front *tarsi* large, with a small, black comb. Length, 2.5 mm.

Hab.—Queensland: Herberton, in February (C. J. Wild); unique.

The apical portion of the prothorax is deeply sculptured, but not as in *H. imperator,* from which it also differs in the colour and sculpture of head, entirely pale elytra, etc.; *H. incisicollis* has a deep medio-apical notch, but the prothorax is otherwise normal; *H. spinicollis* has a simple spine.

HELCOGASTER CERATICEPS, n. sp.

♂. Black; head, prothorax, four basal joints of antennae and legs flavous-red. With numerous long, dark hairs on sides, sparser elsewhere.

Head wide, with a large, deep, irregular, transverse, inter-ocular excavation, with two small tubercles in front, and a larger one close to each eye; base with dense punctures. Antennae moderately long. *Prothorax* distinctly transverse, sides rather strongly rounded, a shallow open depression near base. *Elytra* short and almost impunctate. Basal joint of front *tarsi* with a small black comb at inner apex. Length (♂, ♀), 3.5-4 mm.

♀. Differs in having the head opaque and densely punctate, and without excavation or tubercles, antennae thinner, abdomen wider, and front tarsi combless.

Hab.—Victoria: Sea Lake (J. C. Goudie's No. 828).

A very distinct species nearer *H. major* than any previously described species, but narrower, excavation of head of male somewhat different, the tubercle near each eye more prominent, antennae thinner, much less strongly serrated and mostly dark (a few of the joints beyond the fourth are obscurely diluted with red, but the apical ones are black), elytra shorter and comb of tarsi much smaller. *H. coelocephalus, H. hoplocephalus,* and *H. aterrimus* are much smaller species, and very differently coloured. The head when viewed from behind is seen to have four tubercles: two small conical ones in front, and a larger and somewhat curved one, projecting like a horn above each eye. The posterior margin of the excavation is almost straight, but its anterior one is irregular.

HELCOGASTER CONVEXICEPS, n. sp.

♂. Flavous; apical three-fourths of elytra, metasternum, and six apical joints of antennae black. With sparse, dark hairs.

Head rather strongly and evenly convex; with numerous small, and rather distinct punctures. Antennae longer than usual, none of the joints transverse. *Prothorax* with sides narrowed to base; a rather large, transverse, closed, subbasal depression; with fairly distinct punctures scattered about. *Elytra* moderately long; with numerous very minute, rugulose punctures. Basal joint of front *tarsi* with a small black comb. Length, 2.25 mm.

Hab.—New South Wales: Illawarra, one specimen in October (G. E. Bryant).

The head rather strongly convex, nonexcavated, and with distinct punctures, distinguishes from *H. trisinuatus*, the absence of a frontal tubercle from *H. humeralis* and *H. seminigripennis*, and the very different prothorax from *H. thoracicus*. In my table (*l.c.*, p. 216) it would be associated with *H. simpliciceps*, whose head is much less convex, abdomen black, and pale portion of elytra continued along sides.

CHRYSOMELIDAE.

MACROGONUS VENTRALIS, n. sp.

Flavous; head (except base and muzzle), scutellum, elytra, abdomen (except part of basal segment), tarsi, and most of tibiae dark metallic green, with a more or less distinct purplish gloss, a fairly wide median vitta on prothorax, and an oblique spot or vitta towards each side also greenish, five basal joints of antennae shining purple, the others opaque purple; tip of mandibles and apical joint of palpi infuscated.

Head with a triangular inter-ocular impression, connected with the base by a median line; punctures rather sparse and small, a few larger ones near eyes. Antennae long, extending to about middle of abdomen. *Prothorax* about one-third wider than median length, all angles slightly armed, apex slightly wider than base, and slightly incurved at middle, sides gently rounded in middle; with sparse and rather small punctures about middle, becoming larger on sides, but all sharply defined. *Scutellum* long and triangular. *Elytra* much wider than prothorax, each with three shallow depressions or foveae, triangularly placed: one on the side at the basal fourth, one half-way between it and suture, the other equidistant from the two front ones; with rows of punctures of moderate size near base, becoming smaller posteriorly; interstices each with a row of very small punctures. Length, 8 mm.

Hab.—New South Wales: Comboyne (W. H. Muldoon), unique.

The type is evidently a female; it is too close to the female of *M. bifoveicollis* to be regarded as other than a *Macrogonus*, but possibly with other species of that genus may eventually be transferred to *Macrolema*. The prothorax is nonfoveate, but there is a vague depression on each side of the base. The oblique vittae on the prothorax appear to be hardly more than stains, each extends from near the middle of the apex to near the middle of the side; on each side near the apex, and invisible from above, there is also a stainlike spot; although the elytra are dark green, the colour alters with the point of view to dark blue, and then to purple.

EROTYLIDAE.

EPISCAPHULA TETRASTICTA, n. sp.

Metallic purple; elytra with four flavous spots, under surface except sides of prosternum, palpi and parts of legs reddish-flavous, rest of legs and antennae blackish, but in places obscurely diluted with red.

Head with distinct but not very large or dense punctures, becoming smaller and denser on clypeus. Third joint of antennae more than twice the length of fourth. *Prothorax* more than twice as wide as long, sides diminishing in width from base, front angles produced but not very acute; punctures somewhat smaller and sparser than on head; submarginal line deep. *Elytra* slightly dilated from shoulders to about basal fourth, and then narrowed to apex; with rows of distinct, but not very large punctures, the interspaces with much smaller ones. *Abdomen* with coxal lines traceable to apex of basal segment, but rather faint posteriorly. Length, 5.75-6 mm.

Hab.—Queensland: Cairns (E. Allen).

A small, rather wide species, allied to *E. inclusa*, but smaller and elytra with four isolated, pale spots, placed as in the angles of a square: two basal and two median, each of the latter occupies the space between about six lines of punctures, each of the former between about four.

THALLIS BASIPENNIS, n. sp.

Chocolate-brown; elytra, under surface, legs and palpi paler. Densely clothed with pale pubescence, becoming conspicuously golden on base of elytra.

Head with crowded punctures of moderate size. Antennae with third joint about once and one-half the length of second; club not very large. Apical joint of each palpus scarcely larger than basal joint of antennae, and not securiform. *Prothorax* about once and one-fourth as wide as long, apex widely truncated, scarcely notched near each side, sides gently rounded, front angles scarcely produced, the hind ones acute; with crowded but not very large punctures, many of which are slightly confluent longitudinally. *Elytra* no wider than prothorax, and scarcely twice its length; with regular rows of punctures in distinct striae, interstices gently convex, separately narrowly elevated at base, with dense punctures. *Prosternum* with intercoxal process narrow, its hind end truncated. Coxal lines of *abdomen* faintly traceable to apex of basal segment. Length, 4.5-5 mm.

Hab.—North Western Australia: Upper Ord River (R. Helms).

The elytra appear to be fasciate at base, the fascia interrupted at suture, but this appearance is really due to the bright golden pubescence there; at the base they are very narrowly elevated, and the scutellum is elevated in the same line. Owing to the convexity of the pronotum the impressed line on each side is only visible at base and apex from directly above. One specimen has the elytra no paler than the prothorax, and the basal fascia of pubescence hardly golden. The species may be eventually transferred to a new genus, as the base of its elytra and apical joint of each palpus are aberrant.

EUXESTUS VENTRALIS, n. sp.

Black; head, apex of elytra, and epipleurae obscurely reddish, legs, antennae and palpi castaneo-flavous. Glabrous.

Head with dense and small but sharply defined punctures, a small fovea on each side of clypeus. Antennae short, basal joint large, club slightly wider than

long. *Prothorax* at base about thrice as wide as the median length, base bisinuate, apex gently incurved to middle, margins very narrow; punctures rather dense and small, but sharply defined. *Elytra* with outlines continuous with those of prothorax, widest at about basal fourth; with dense and moderately strong punctures, more or less seriate in arrangement. *Abdomen* with coxal lines distinct, and marking the outer edge of a plate, on each side of which the punctures are larger than elsewhere. Length, 2.25-2.75 mm.

Hab.—New South Wales: Forest Reefs (A. M. Lea).

An evenly elliptic, moderately convex species, with the general outlines of mainland specimens of *E. tasmaniae,* but elytra with rather dense punctures, many of which are in regular lines, but not in impressed striae, whereas on that species the striation is conspicuous and the punctures much less in evidence; on the pronotum, however, the punctures are alike on both species. Structurally it is extremely close to and is certainly congeneric with the New Zealand *Triplax brouni* Pasc., but with stronger punctures and slightly different antennae, at first glance the two species appear to be identical. There are twelve specimens of the typical form before me.

VAR. I. Six specimens from Forest Reefs (Lea), and one from Blue Mountains (Dr. E. W. Ferguson), differ in having an obscurely reddish fascia (interrupted at the suture) at the base of the elytra, more of the apex reddish, and the under surface reddish but with the metasternum infuscated. Compared with *E. bivulneratus* these specimens differ in being narrower and less convex, in having the basal markings more obscure, more of the apex reddish, the punctures much stronger, and the coxal lines more distinct.

EUXESTUS ATER, n. sp.

Black; parts of under surface obscurely diluted with red, legs antennae and palpi castaneous. Glabrous.

Head with small but sharply defined punctures; a small fovea on each side of clypeus. Antennae short, basal joint large; club slightly wider than long. *Prothorax* not thrice as wide as long, base bisinuate and much wider than apex, the latter gently incurved to middle, sides very finely margined; punctures sparse and small. *Elytra* with sparse and small punctures, some of which appear to be in feeble lines towards base. *Abdomen* with coxal lines enclosing a distinct plate on each side. Length, 2-2.25 mm.

Hab.—Queensland: Brisbane (A. J. Coates).

The outlines are intermediate between those of *E. bivulneratus* and *E. ventralis;* from the former it is also distinguished by the absence of basal markings on the elytra, from the latter by the considerably smaller and sparser punctures; it is slightly more convex than *E. medioniger.* The muzzle is not as dark as the base of the head, but at first glance the whole of the upper surface appears to be of a polished black; the joints preceding the club are slightly darker than the rest of the antennae, but this appears to be the case with most species of the genus.

EUXESTUS ATROPOLITUS, n. sp.

Black, highly polished; legs antennae and palpi castaneous, tips of elytra obscurely diluted with red.

Head with sparse and minute punctures, sharply defined only on clypeus. Antennae short, club slightly wider than long. *Prothorax* about thrice as wide at base as the median length, apex gently incurved to middle, sides and base very

narrowly margined. *Elytra* with outlines continuous with those of prothorax, widest at about basal third. *Abdomen* with coxal lines enclosing a distinct plate on each side. Length, 1.75 mm.

Hab.—New South Wales: Tamworth, Clarence River (A. M. Lea).

Much the size and shape of *E. vulneratus,* but upper surface entirely black except for the tips of elytra. Under a hand-lens the prothorax and elytra appear to be impunctate.

VAR. ?. Two specimens from the Nepean River (A. J. Coates), and Clarence River (Lea), are possibly varieties of this species, they are of a livid-brown colour with a large infuscate blotch on the elytra, and another on the metasternum, both blotches quite conspicuous, although not sharply limited.

DIPHYLLUS FLAVONOTATUS, n. sp.

Black, apical third of elytra and six spots across the middle flavous, legs, antennae, and palpi flavo-testaceous. Densely clothed with short, suberect pubescence, varying in colour with the derm.

Head with small and crowded punctures. Antennae scarcely passing base of prothorax; club two-jointed. *Prothorax* more than thrice as wide as long, with a sharply defined stria near each side, and a less distinct one near it; punctures much as on head, except on sides, where they are somewhat larger. *Elytra* with outlines continuous with those of prothorax; with regular rows of punctures, fairly large at base, becoming smaller posteriorly; interstices with small, partially concealed punctures. Length, 2 mm.

Hab.—New South Wales: Ourimbah (A. M. Lea). Unique.

An evenly elliptic species, shorter and more compact than *D. ornatellus,* and elytral markings very different; the spots across the middle are not in a straight line, but so placed that the median one on each elytron is slightly posterior to the others; the pale apical portion is triangularly advanced on the suture.

DIPLOCOELUS XANTHORRHOEAE, n. sp.

Reddish-brown or castaneous, appendages not much paler. Densely clothed with short, depressed, greyish pubescence, the upper surface in addition with rows of short, semi-erect setae.

Head with small and dense punctures. Antennae short, club three-jointed. *Prothorax* slightly more than twice as wide as long, sides gently rounded, front angles scarcely produced, with (excluding the margins) ten slightly elevated, parallel lines, of which the four median ones are, except for their clothing, scarcely traceable; punctures much as on head, but slightly larger towards sides. *Elytra* parallel-sided to near apex, the width of widest part of prothorax; with regular rows of punctures of moderate size, becoming smaller towards suture; interstices with small punctures. Length, 2.75-3.25 mm.

Hab.—Western Australia: Swan River, Darling Ranges; New South Wales: Sydney; Tasmania: Huon River (A. M. Lea).

The species may be taken at the bases of the leaves of several species of *Xanthorrhoea.* It is allied to *D. opacior* (specimens of which have also been taken on species of *Xanthorrhoea*), but is larger, paler, and the prothoracic lines of clothing are much more evident; *D. punctatus* has the prothorax with much coarser punctures and lines of pubescence scarcely evident, although with distinct grooves; *D. latus* is wider, with coarser punctures, etc.; *D. decemlineatus* has median line of prothorax distinct, and elytra not parallel-sided; *D. dilataticollis*

has middle of prothorax wider than elytra. The smallest specimen is but slightly more than an English line in length, and as the ninth joint of its antennae is only moderately narrower than the tenth the species is evidently allied to *D. exiguus*, from the description of which it differs in having the prothoracic punctures dense and fine (larger on the sides than in the middle), and elytral punctures also evidently much smaller. The larger specimens are slightly wider in proportion than the smaller ones, and the median elevations of the prothorax are even less distinct.

DIPLOCOELUS APICICOLLIS, n. sp.

Castaneous, appendages slightly paler. Moderately densely clothed with short, depressed, greyish pubescence, upper surface in addition with short, semi-erect setae.

Head with dense punctures of moderate size; a shallow depression on each side of clypeus. Antennae short, ninth joint slightly larger than eighth but much smaller than tenth, the latter wider than eleventh. *Prothorax* not twice as wide as long, sides obliquely increasing in width to apex, front angles sharply defined and not produced, the hind ones gently rounded off, with three more or less distinctly impressed lines towards each side; punctures somewhat irregular, but mostly well defined. *Elytra* parallel-sided to near apex, with rows of fairly large punctures, becoming smaller posteriorly; interstices with small punctures. Length, 2.5-2.75 mm.

Hab.—Western Australia: Swan River (J. Clark and A. M. Lea), Donnybrook (Lea).

Of the size and general appearance of *D. angustulus*, but with front of prothorax decidedly wider; when seen from above the front angles appear to be quite sharply angulate, but on that species, from a similar point of view, they appear to be gently rounded off; the head of the present species is also more transverse. At first glance the club appears to be but two-jointed, and perhaps should really be so considered, but the ninth joint is certainly wider than the eighth.

ENDOMYCHIDAE.

STENOTARSUS PARALLELUS, n. sp.

Flavous-red; head, base of prothorax, scutellum, two large spots on elytra, antennae, femora, and tibiae black. Moderately densely clothed with pale, semi-erect pubescence.

Head with numerous small but distinct punctures; a shallow depression near each eye. Antennae rather short; club stout. *Prothorax* with front angles produced and rounded, sides almost parallel elsewhere, sublateral striae deep, becoming foveate at base; with numerous small but sharply defined punctures, becoming larger and denser on sides. *Elytra* long, parallel-sided to near apex; with rows of rather large punctures, becoming smaller towards suture and posteriorly; interstices with small punctures. Length, 2.75-3.25 mm.

Hab.—New South Wales (Dr. E. W. Ferguson), Sydney (H. J. Carter and A. M. Lea), Gosford (Carter).

The elytra are longer and more parallel-sided than in any previously described Australian species; they have two large spots, somewhat as in *S. bimaculipennis*, but that species is decidedly wider and more elliptic, and its legs and head are red. On several specimens the basal half of the prothorax is black,

but on others the black does not extend to the sides, the spot on each elytron is median, of irregular shape, and extends across about five interstices.

STENOTARSUS ALTERNATUS, n. sp.

Black; an obscure spot on each side of prothorax, four vittae on elytra, and elytral epipleurae more or less red. Moderately clothed with semi-erect, rusty hair.

Head with small punctures, a shallow depression between eyes. Antennae comparatively long, club stout, apical joint almost as long as two preceding combined. *Prothorax* with sides strongly rounded in front, apex almost semicircularly emarginate, sublateral striae deep, becoming foveate at base; with small but rather sharply defined punctures, becoming rather coarse and dense on sides. *Elytra* with rather strongly rounded sides, widest at about basal fourth; with rows of rather large punctures in feeble striae, the interstices with small but distinct punctures. Length, 3.25 mm.

Hab.—New South Wales: Kiama (unique).

Structurally close to *S. arithmeticus*, and to several other species, but red elytral markings longitudinal; the vittae commence at the base and terminate near the apex, they are on the third and seventh interstices, but the one on the seventh is interrupted on each elytron near the base; the spot on each side of the prothorax is distinct immediately behind the eye, but may be traced almost to the base; the tarsi and palpi are obscurely diluted with red.

PERIPTYCTUS BRYOPHILUS, n. sp.

Flavous; middle and hind angles of prothorax, scutellum, greater portion of elytra, middle and base of prosternum, part of abdomen, coxae and club, more or less deeply infuscated. Upper surface glabrous, under surface almost so.

Head with fairly dense and sharply defined punctures. Antennae rather long, first joint stout, second as long as first but much thinner, third-eighth small, ninth-eleventh forming a club. *Prothorax* at base scarcely twice as wide as the median length, sides thickened and strongly rounded, apex about half the width of base and gently incurved to middle, base bisinuate, hind angles acute, convex along middle, concave towards each side; punctures sparse and inconspicuous. *Scutellum* widely transverse. *Elytra* slightly wider than prothorax, a subfoveate impression on each side of base; with rather large punctures; in places somewhat seriate in arrangement, but not in striae. *Under surface* with numerous rather small but sharply defined punctures, less conspicuous on chin-piece than elsewhere. Length, 2.25-2.5 mm.

Hab.—Tasmania: Mount Wellington (A. M. Lea).

A beautiful little species of which two specimens were obtained from moss. It is larger and wider than *P. russulus*, very differently coloured, sides of prothorax different, elytral punctures larger, etc.; from the description of *P. eximius* it differs considerably in colour and sculpture. On the larger specimen the dark parts of the prothorax are almost black, its elytra have the basal fifth, except for a spot half-way between the scutellum and each shoulder, and sides pale, enclosing a large shield-shaped space, and its abdomen has a large subtriangular dark space; on the smaller specimen the markings are less dark, and much less of the abdomen is infuscated. The joints of the club are flattened, and from one point of view appear scarcely wider than the preceding joints, but from another point they appear almost thrice as wide.

PERIPTYCTUS LATERICOLLIS, n. sp.

Red; head, scutellum and most of prothorax infuscated, apical half of antennae blackish, each shoulder with a flavous spot. Upper surface glabrous, under surface slightly pubescent.

Head with a small impression near each eye. Antennae moderately long, first joint stout, second slightly longer, and much thinner than first, ninth-eleventh forming a rather wide club. *Prothorax* along middle longer than width of apex, sides thickened, on basal half strongly raised and almost parallel, strongly narrowed and less elevated to apex, which is gently emarginate; punctures sparse and inconspicuous. *Elytra* wider than prothorax, sides moderately rounded, shoulders rather strongly raised; with rather sparse and small punctures, but in places seriate in arrangement. *Prosternum* with chin-piece subtriangularly advanced, a groove on each side of it. Length, 2.5 mm.

Hab.—Queensland: Mount Tambourine (C. Wild). Unique.

Larger than *P. russulus*, with the sides of prothorax suddenly and strongly elevated in middle, and with the chin-piece more prominent, etc.; it differs in many respects from the description and figure of *P. eximius*. The hind angles of the prothorax are almost spiniform, and project obliquely outwards; its disc is deeply infuscated, with the sides, especially in front, paler; part of its under surface is also dark; the punctures of the under surface are rather sparse and small on the abdomen, rather large but sparse on sides of metasternum, and fairly dense and large on parts of the prosternum.

IDIOPHYES VIRIDIS, n. sp.

Dark metallic-green, with a coppery gloss; under surface, legs, antennae and palpi more or less castaneous. Upper surface moderately densely clothed with long, suberect pubescence, under surface and legs with much shorter and depressed pubescence.

Head rather wide; with dense, small, and (when not partially obscured by clothing) sharply defined punctures. Antennae moderately long, basal joint stout, about half as long again as second, second stouter and slightly longer than third, fourth and fifth slightly decreasing in length, sixth and seventh slightly shorter and wider than fifth, eighth-tenth forming a conspicuous club, eighth and ninth each about as long as first, but much wider, tenth about half as long again as ninth. *Prothorax* at base about thrice as wide as the median length, sides strongly rounded, apex much narrower than base, a conspicuous groove towards each side, becoming wider at base, a narrow impressed line very close to base; punctures crowded and sharply defined. *Elytra* strongly convex, sides subcontinuous with those of prothorax, a small tubercle towards each side near apex; with rows of fairly large punctures in rather shallow striae; interstices with small, dense punctures. Length, 2 mm.

Hab.—Tasmania: Hobart (A. M. Lea).

A beautiful little species of which four specimens were obtained from moss. Structurally it is close to *I. brevis*, and the antennae are also ten-jointed; but the upper surface is green, with longer clothing, and the prothoracic punctures are much more conspicuous.

IDIOPHYES DUBIUS, n. sp.

Reddish-castaneous; legs, antennae and palpi somewhat paler. Not very densely clothed with moderately long, suberect setae or pubescence.

Head with rather dense small punctures. Antennae moderately long, first joint stouter and slightly longer than second, second stouter and longer than third, fourth-eighth gradually decreasing in length, ninth somewhat longer and distinctly wider than eighth, tenth still longer and wider, eleventh slightly wider and about half as long again as tenth. *Prothorax* at base scarcely twice as wide as the median length, sides rather strongly rounded, and somewhat narrower in front than behind; with a deep, continuous stria near each side, and another one at base; punctures small but sharply defined. *Elytra* at base slightly wider than base of prothorax, widest at about basal third; with rows of rather large punctures, becoming somewhat larger and more irregular about base, and smaller posteriorly; epipleurae fairly wide at base, very narrow beyond middle, and disappearing before apex. *Under surface* with dense punctures, larger on metasternum and basal segment of abdomen than elsewhere, the latter about as long as three following segments combined, a small sixth segment traceable. *Legs* not very long; front coxae separated by a narrow keel. Length, 1.25-1.5 mm.

Hab.—Tasmania: Hobart (A. M. Lea).

At first glance this species appears to be a *Mycetaea*, but the third joint of its tarsi is minute and anchylosed to the fourth, instead of almost as conspicuous as the second. It was referred with doubt to *Idiophyes*, as the antennae are eleven-jointed; it is decidedly narrower than *I. brevis*, the elytral epipleurae are narrower, and the clothing and punctures are different.

IDIOPHYES HUMERALIS, n. sp.

Castaneous; shoulders, elytral epipleurae, legs and palpi paler, club (its tip excepted) infuscated. Moderately clothed with semi-erect, pale pubescence, sparser and depressed on legs and under surface.

Head with two shallow interocular depressions; punctures indistinct. Antennae rather short, eleven-jointed, three apical joints forming a conspicuous club. *Prothorax* at base almost four times as wide as the median length, sides thickened, oblique, but rounded in front; a narrow deep stria near each side, closed posteriorly but open behind the eye, bounded internally by an acute ridge; apex incurved at sides but straight in middle, very finely margined, a narrow impression across base; with fairly numerous punctures towards sides, but sparse in middle. *Scutellum* small and widely transverse. *Elytra* short, slightly wider at base than prothorax, strongly rounded beyond middle, a rather deep impression at base near each shoulder, sides distinctly margined; with fairly large, sharply defined and numerous, but not crowded punctures; a feeble stria on each side of suture. *Prosternum* with a distinct median keel, which is bistriated between coxae. Length, 1.5 mm.

Hab.—New South Wales: Sydney (A. M. Lea).

A short, strongly convex species, the pale shoulders rendered more conspicuous by the depression at the inner side of each. In general appearance nearer *I. brevis* than *I. dubius*, but the eleven-jointed antennae associate it with the latter. On parts of the under surface the punctures are dense and sharply defined, but they are much smaller in places; the abdomen appears to have a minute sixth segment, but it may be an extrusible one; the prothorax is almost glabrous in the middle.

CORYLOPHIDAE.

APHANOCEPHALUS POTAMOPHILUS, n. sp.

Dull reddish-castaneous; legs, antennae and palpi paler, part of elytra infuscated. Rather densely clothed with pale, short, semi-erect pubescence.

Head with dense, partially concealed punctures. *Prothorax* almost four times as wide as the median length, sides strongly rounded and finely margined, apex gently incurved to middle and about half the width of base; with small, dense, partially concealed punctures. *Elytra* with outlines and margins continuous with those of prothorax; with small, dense, partially concealed punctures. *Under surface* with rather small but sharply defined punctures, smaller in middle of metasternum than elsewhere. Length, 2-2.25 mm.

Hab.—North Western Australia: Upper Ord River (R. Helms).

An oblong-elliptic species, obtained in abundance at the water's edge. It is larger, wider and with smaller and denser punctures than *A. punctulatus;* placed side by side the punctures on the elytra of the present species are only about half the size of those of that species. The infuscation of the elytra consists of a large, median spot, varying considerably in size, but apparently never sharply defined. Under a compound power the basal joint of the antennae appears fairly stout, third slightly longer than fourth, distinctly longer than second, and slightly shorter than first, seventh and eighth rather short, and ninth as a stout one-jointed club, about as long as the four preceding combined.

APHANOCEPHALUS PALLIDIPENNIS, n. sp.

Pale reddish-castaneous; legs, antennae (club excepted) and palpi somewhat paler, head and prothorax blackish or deeply infuscated, sides of the latter obscurely diluted with red. Densely clothed with short, pale, depressed pubescence. Length, 1.6 mm.

Hab.—Queensland: Cairns (C. J. Wild), Little Mulgrave River (H. Hacker).

The description of the sculpture of the preceding species applies exactly to the present one, but the latter is much smaller, differently coloured and with different clothing; on the elytra the pubescence has a slightly mottled appearance, and from one direction on the right seems condensed so as to form a pale S (reversed on the left elytron). The size and shape are much as those of *A. poropterus*, but the elytra are reddish and with much less conspicuous punctures; the curious undulations of the clothing, to a certain extent, suggest the basal markings of that species.

APHANOCEPHALUS QUADRIMACULATUS, n. sp.

Black or blackish, parts of appendages obscurely paler; elytra with four, fairly large, round, red spots. Clothed with very short, inconspicuous pubescence. Length, 2 mm.

Hab.—Queensland: Hamilton (C. J. Wild).

Slightly more elliptic than *A. potamophilus*, with prothorax wider at apex and punctures less concealed by clothing; the elytral spots are placed as if marking the corners of a square: two at the basal third and two at the apical third; it is larger than *A. quadrinotatus*, and the spots are quite round, without showing a tendency to become confluent; structurally it is nearer *A. bimaculatus*. One of the specimens has the whole of the under surface obscurely brownish.

NOTE ON THE PIGMENTATION OF FROGS' EGGS.

By LAUNCELOT HARRISON, B.Sc. (Syd.) B.A. (Cantab.), Acting-Professor of Zoology in the University of Sydney.

On page 4 of the second volume of the new Text-book of Embryology (Vol. ii., Vertebrata, Macmillan, London, 1919) Professor Graham Kerr makes some observations upon the pigmentation of the egg in Ganoids and Amphibians. These remarks would appear to be based upon the experience of a limited group of workers with a small number of frog species. While nothing is stated dogmatically by Professor Kerr, his remarks have the appearance of a general statement, yet they are not in accord with my own observations upon the eggs of Australian Anura. It has appeared to me, therefore, worth while to place on record the discrepancies I notice, particularly as the Text-book will be used largely by students whose powers of discrimination have not been developed, and who are apt to consider as conclusive any statement that they read in such a work.

Professor Kerr writes:—"Many eggs on the other hand especially amongst the Ganoid fishes and the Amphibians are given a dark colour by the presence within them of brownish-black pigments belonging to the melanin group. Such pigment appears to be of definite biological significance, providing as it does an opaque coat which protects the living protoplasm from the harmful influence of light. Eggs in which it occurs develop, as a rule, under conditions where they are exposed to intense daylight. The eggs of ordinary Frogs and Toads for example which are surrounded by clear transparent jelly have a well developed pigment coat. On the other hand in the case of Frogs and Toads whose eggs are surrounded by light-proof foam or are deposited in burrows underground they are commonly without pigment.

"In all probability this deposition of melanin pigment in the superficial protoplasm of the egg (normally in its *upper* portion) is to be interpreted as having been originally a direct reaction to the influence of light, the metabolism being so affected as to bring about the formation of this particular iron-containing excretory pigment.

"It may be objected that the pigment is produced before the egg is laid (*e.g.* the Common Frog) and therefore before it is exposed to the action of light, but as a matter of fact the body-wall of the adult is by no means opaque to light rays and even while still in the ovary the eggs are exposed to the influence of faint light. If we may take it, as seems probable, that the

influence of natural selection has gradually developed in such cases the particular type of sensitiveness to light which leads to the formation of melanin, on account of its protective value, then there is nothing surprising in the developing of this sensitiveness at earlier and earlier periods until at last it has resulted in the pigmentation of the still intra-ovarian egg in response to the feeble light rays which penetrate the body wall."

There can be no disagreement with a statement that the eggs of most Anura have a pigmented upper pole. This may vary in size from a small polar cap (*Pseudophryne*) to considerably more than a hemisphere (*Rana temporaria*); and in colour from light brown (*Hyla ewingii*) to intense black (*Crinia signifera*). But several instances have been given of Anuran eggs which are without pigment.

Thus Agar (1909, p. 895) writes of *Phyllomedusa sauvagii*—"The eggs are quite unpigmented, and any that are exposed to the surface, as happens often in less perfectly formed nests, turn yellow and die." Budgett (1899, p. 315) mentions the spawn of *Phyllomedusa hypochondrialis* as—"batches of white eggs in masses of firm jelly." Agar's Figure 2 shows quite plainly that the intra-ovarian eggs are without pigment. In the case of *Phyllomedusa*, then, we have undoubted white eggs, presumably as the eggs are enclosed in light-proof foam. But *Phyllomedusa* is a small, comparatively translucent frog, which lies by day on the upper surfaces of leaves, fully exposed to light (Budgett, 1899, p. 314); so that if pigment be a direct reaction to light, one would expect to find in this case the eggs definitely pigmented.

In three species of *Limnodynastes* with the breeding habits of which I am familiar, the eggs are also laid in a mass of foam, which from its nature must reflect and refract so much incident light as to be practically light-proof. Yet the eggs are densely pigmented, as are the developing larvae. *L. dorsalis* is a burrowing frog, never seen by daylight at ordinary times, and resorting to water only for a day or two in the breeding season. *L. peronii* is a cryptozoic form, found under stones, etc., by day, and resorting to water at night. This species may, however, be found in the water during the daytime within the limits of its spawning season. *L. tasmaniensis* is also cryptozoic, and I have only once found it in water by daylight. None of these species would appear to be susceptible to the influence of daylight acting through their robust body-wall, yet the intra-ovarian eggs are densely pigmented. It may be noted in passing that eggs entangled in the upper portion of the foam die, not from exposure to light, but because of insufficient moisture in this region.

There is thus a very marked difference between *Phyllomedusa* and *Limnodynastes*, and it would seem that the explanation of pigmentation is further to seek than Graham Kerr's general statement would have us believe.

Besides *Phyllomedusa*, certain other frogs have been reported as laying eggs without pigment. Of *Paludicola fusomaculata* Budgett writes (1899, p. 309)—"The eggs . . . are found embedded in a frothy mass floating upon the surface of the water, ... and are without pigment." Bles (1907, p. 445) dealing with Budgett's material of this species writes—"The ovum is quite free from pigment. In the earliest stage examined, the blastopore is very small." In view of what I have to say below, the latter sentence may bear some significance. Otherwise *Paludicola* spawn would appear to resemble that of *Limnodynastes*, except for the absence of pigment.

Budgett (1899, p. 311) records the nests of *Engystoma ovale* as—"holes in the ground beneath fallen tree trunks, of the size of a cricket ball and lined with a froth containing white eggs, and also tailed larvae."

Bles (1907, p. 451), describing Budgett's Gambia material of *Hemisus marmoratum,* writes:—"The earliest stages which were preserved are late segmentation stages of which there is nothing special to note except that the eggs are quite without pigment."

Finally Dakin (1920, p. 242) describes the eggs of *Heleioporus albopunctatus* as "somewhat large and without pigment." These eggs were laid at the bottom of burrows 18 inches deep, in friable sandy soil, and were enclosed in a mass of frothy mucus.

It would appear then on the face of it that unpigmented frog's eggs are of comparatively common occurrence. But the condition that I find in the eggs of *Pseudophryne australis* and *P. bibronii* causes me to suspect that many eggs described as being without pigment may not really be so. In these species the unsegmented egg has a black upper pole, occupying in section about one-sixth of the circumference of the egg. During the early stages of segmentation the micromeres are confined to this cap, which retains its black colour. As overgrowth proceeds, however, the pigmented area extends, but loses its intensity of colour, so that by the time the blastopore has become circular the whole pigmented area is of so pale a grey as to be distinguishable with difficulty from the white yolk. In eggs which have been preserved the distinction is even less marked. Pigment appears again during the formation and closure of the neural groove, but the embryo, when folded off, is practically without pigment.

In this case unless the eggs were observed in the early segmentation stages they might easily be described as without pigment. As most of the eggs described as unpigmented are of a similar heavily yolked type, I believe the same thing may have happened in some at least of these cases. Eggs of *Heleioporus* kindly sent me by Professor Dakin have all passed beyond the stage of early segmentation, and have an appearance precisely similar to that of *Pseudophryne* eggs. In Budgett's material mentioned above, of *Paludicola* and *Hemisus* there are no early segmentation stages. The material of *Engystoma* would appear to have been lost, as no mention of it occurs in Bles' report (1907).

From appearances observed in two species of *Pseudophryne,* and in several species of *Hyla,* the amount of pigment present seems to bear a definite relation to the protoplasmic mass of the egg. The addition of further yolk to the bulk of the egg in the course of evolution is not accompanied by a compensating addition of pigment. As overgrowth proceeds, the amount of pigment present appears to remain practically constant. In small yolked eggs which are densely pigmented there is little or no diminution of intensity of colour during overgrowth. In large-yolked eggs, however, owing to the much greater area which has to be covered by the pigment, there is a very definite lightening in colour, from the black to palest grey in *Pseudophryne,* from dark brown to light yellowish brown in several species of *Hyla,* as overgrowth proceeds.

This view is opposed to that of T. H. Morgan (1891, p. 758) who maintains that black cells do not overgrow light, but that new pigmented cells are cut off from the upper corners of the yolk cells, and—"there is a continuous formation of new pigment taking place at the periphery of the black area within the new cells that are being formed." Pigment production is admittedly a product of active metabolism, and one would expect to find pigment being formed in the region of the germ ring, but, in the eggs I mention, this would not appear to be sufficient to greatly affect the colour of the egg surface.

Finally, both species of *Pseudophryne* are cryptozoic in habit hiding by day under logs and heaps of refuse, and laying their eggs in similar situations.

Here again it seems impossible that the pigment of the egg should have been produced in response to the direct stimulus of light, and a supposition that *Pseudophryne* has only recently taken to a cryptozoic habit, and has not yet succeeded in eliminating pigment, hardly helps matters.

Regarding the pigmentation of tadpoles, I can confirm the observations of Wenig (1913) that those which develop in water with clay in suspension do not develop normal pigment. I recently captured some tadpoles of *Limnodynastes* at a depth of five feet in a muddy creek, in a net sunk for crayfish. The normal tadpole has a uniform dense pigmentation, but these individuals were almost transparent, except for two lines of chromatophores dorso-laterally along the main muscle mass, and the whole brain showed white through the dorsal surface. Here there has been an obvious relation between light and pigment development.

For the eggs, however, the matter is apparently not so simple, and an enquiry into the nature and mechanism of production of these pigments, and into the purpose they subserve, seems called for.

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ON A SPECIMEN OF *NOEGGERATHIOPSIS* FROM THE LOWER COAL MEASURES OF NEW SOUTH WALES.

By A. B. Walkom, D.Sc.

(Plate xxv.)

The object of the present short note is to place on record a remarkably fine specimen of *Noeggerathiopsis*, from between the two splits of the Greta Seam in the Lower Coal Measures of New South Wales.

There is no need here to give any historical account of the genus in Australia, for the late R. Etheridge, Jr., has gone into this very fully in a recent paper (Geol. Mag., July, 1918, pp. 289-293). He there described four clusters of leaves, bringing the number of specimens found in Australia, showing the radiate arrangement of the leaves, up to seven. The specimen described here also shows this arrangement and is far larger than any previously described; it brings the number up to eight. It was exhibited by Mr. C. A. Sussmilch before the Geology Section of the Royal Society of N.S.W. (Journal, liv., 1920, p. xxxiv.) Associated with the *Noeggerathiopsis*, on the same specimen, are several fragments of leaves of *Glossopteris*. Plate xxv. is from a photograph of the specimen.

The specimen shows the remains of portions of some 13 or 14 leaves attached to a central stem which is from 1.5 to 2 cm. in diameter. The leaves are spread out on a fine-grained grey shale, and arranged in a radiate manner. They are all incomplete, none of them showing the nature of the apex; the majority of them, however, show a considerable portion, while a few only show a few cm. of the basal part. The largest portion of a leaf has a length of 17-18 cm. and gradually becomes broader from the base outwards; it is about 1 cm. broad where it joins the stem, and 3.5 cm. wide at about 17 cm. from the stem. The specimen shows quite clearly that the arrangement of the leaves is not verticillate; this is also of course obvious from the fact that there are about 14 leaves present, each being about 1 cm. wide at the base, and attached to a stem whose circumference is apparently not more than about 7 cm. Close examination indicates that the arrangement is probably spiral, though one cannot determine the phyllotaxy.

The venation is rather coarse, the veins slightly divergent and bifurcating from time to time. There are about 14 veins per cm. on an average, but there is no sign of any finer venation between the coarser veins, such as has been observed in species of *Cordaites*. It may be noted, however, that quite frequently the veins have the appearance of being arranged in pairs. It was because of the absence of these interstitial veins together with the fact that the stomata appeared to be less regularly arranged that Zeiller retained the name *Noeggerathiopsis* in preference to *Cordaites* for these leaves.

Interstitial veins have however since been found on specimens of *Noeggerathiopsis* from India and South America (*see* Seward, Fossil Plants, iii., p. 243),

so that in the absence of specimens having the cuticle well preserved, it is impossible to distinguish between the genera *Cordaites* and *Noeggerathiopsis*. In view of Seward's account (Fossil Plants, iii., p. 243-4) of investigations by the late Miss Ruth Holden, which indicate differences between the Gondwana Land *Noeggerathiopsis* and the European *Cordaites*, we prefer for the present to retain the former name for the Australian examples.

In his paper, quoted above, Etheridge did not discuss the specific identity or otherwise of the Australian specimens of *Noeggerathiopsis*.

As far as I know there is very little at present on which one could separate the leaves specifically, and it seems best to refer them all to *N. Hislopi* (Bunb.). In none of the specimens so far described have any anatomical details been made out, and the only characters on which separation has been based are variations in the shape and venation—the former not at all reliable and the latter hardly any more so in this case. Species described as *N. spathulata* Dana, *N. media* (Dana), from the Upper Coal Measures and *N. prisca* Feistmantel, from the Lower Coal Measures do not appear to be sufficiently distinct to be separated from the widely-known *N. Hislopi*.

In describing a specimen from the Upper Coal Measures of New South Wales as *N. Goepperti* (Schmal.) Arber (Quart. Jour. Geol. Soc., lxviii., 1902, p. 20) says—"As regards the identity of *N. Hislopi* (Bunb.), the representative of this genus in India, South Africa, South America and also probably in Australia with *N. Goepperti*, I have not been able to arrive at a definite conclusion. There is a great similarity of habit and detail between them."

Though specimens showing clusters of leaves are so rare, examples of single leaves are not uncommon in association with the Glossopteris Flora in Australia, both in the Lower and Upper Coal Measures. No well-authenticated specimens are known from newer rocks in Australia.

Attention may here be drawn to a specimen recently assigned to this genus by Shirley (Q'land Naturalist, ii., 1920, p. 82). He describes a fragment from the Ipswich Beds (Upper Triassic) at Albion, near Brisbane, Queensland, as a new species, *N. Tryoni*. I had an opportunity of examining the specimen (of which there is no figure and no record of the location of the type),* and my notes, made at the time, show that I regarded it as a fragmentary piece of a large *Ginkgo* or *Baiera*, showing two segments of the leaf close together with a narrow band of matrix between them; this narrow band of matrix is what has been described as the midrib of *N. Tryoni*.

All the specimens, previously described, showing the radiate arrangement of the leaves of *Noeggerathiopsis* were obtained from the Upper Coal Measures, some from Newcastle, the others from the Illawarra District. The specimen described above, which was obtained from the Stanford Merthyr Colliery, is the first example from the Lower (Greta) Coal Measures; it was forwarded to Mr. Sussmilch by Mr. H. M. Williams, Superintendent of the Stanford Merthyr Colliery, and is now in the collection of the Technological Museum, Newcastle.

I am indebted to Mr. Sussmilch for the opportunity of describing the specimen.

EXPLANATION OF PLATE XXV.

Specimen of *Noeggerathiopsis Hislopi* (Bunb.) showing radiate arrangement of the leaves. (x ½).

* In a recent letter, Mr. H. A. Longman, Director of the Queensland Museum, mentions that this type has been presented to the Museum.

ON THE MANGROVE AND SALTMARSH VEGETATION NEAR SYDNEY, NEW SOUTH WALES, WITH SPECIAL REFERENCE TO CABBAGE TREE CREEK, PORT HACKING.

By MARJORIE I. COLLINS, B.Sc., Linnean Macleay Fellow of the Society in Botany. *

(With Plates xxvi.-xxxii.; and eleven Text-figures.)

The observations recorded in the following paper were commenced during September (Spring) 1916 and continued with some interruptions until June, 1921.

It is the aim of the writer to give an account of the nature of the tidal flats and their vegetation, in the neighbourhood of Sydney, and more especially, to describe a series of changes which have taken place, during the past five years, at Cabbage Tree Creek, Port Hacking.

The writer's thanks are due to Professor T. G. B. Osborn, University of Adelaide, for much helpful discussion throughout the course of the work, and to Mr. J. H. Maiden, F.R.S., Director of the Botanic Gardens, Sydney, who kindly gave her access to the National Herbarium. To Mr. A. A. Hamilton, the writer is indebted for assistance in identification of the various species collected.

PHYSIOGRAPHIC FEATURES OF THE COAST NEAR SYDNEY.

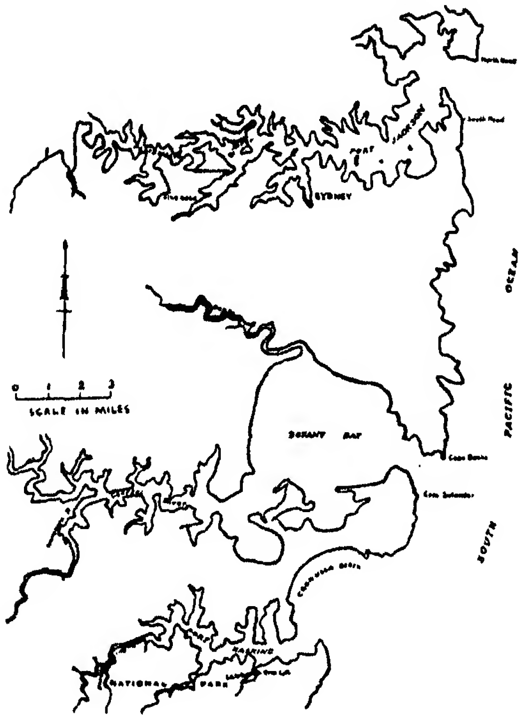
The coastal strip in the neighbourhood of Sydney shows many features of marked physiographic interest. It is characterised by striking, much branched inlets, in which, for the most part, deep water is found close up to the rocky shores. Woolnough says of these ". . . . they owe their existence to the submergence of a partially dissected plateau"; also, "At the close of the latest cycle of erosion there was a general subsidence amounting to at least 400 feet in the central portion of the area. [referring to the coast of New South Wales.] This caused the 'drowning' of the valleys of the coastal rivers, and the conversion of these drowned valleys into magnificent harbours" (Jose, Taylor and Woolnough, 1911, p. 131).

Port Jackson, Botany Bay and Port Hacking, which come within the scope of the present work, all represent drowned river valleys with complex outline (Text-fig. 1). The rocks outcropping on the shores of these inlets, and

*This investigation was commenced in 1916 while the writer held a Science Research Scholarship in the University of Sydney.

for some distance inland, are chiefly Triassic sandstones of the Hawkesbury Series which yield upon denudation a coarse yellow sand.

Since no important rivers flow to the sea in this region, the so-called Parramatta and Lane Cove Rivers merely being arms of Port Jackson, and



Text fig. 1. Map of coast of New South Wales between Port Jackson and Port Hacking showing the nature of the drowned river valleys, and the sheltered arms and bays in which mangrove and saltmarsh occur.

George's River (Botany Bay) and Port Hacking River (Port Hacking) being insignificant streams, silt and detritus are not carried out to sea, but tend to be deposited in sheltered arms and bays.

That there has been comparatively recent subsidence on the coast near Sydney is evidenced in the fact that a bore sunk in the mud at Narrabeen lagoon (north of Port Jackson) disclosed at a depth of over 50 feet layers of Peaty soil containing *Casuarina* cones, and remains of other Xerophytes which now occupy the sandstone country surrounding the lagoon (David and Halligan, 1908, p. 235).

This recent subsidence, together with the physiographic features mentioned above, possibly accounts for the non-existence of such extensive areas of tidal flats as are found in other parts of the world (Ganong, 1903; Harshberger, 1909; Carey and Oliver, 1918); unless the accumulation of silt were sufficiently rapid to keep pace with and overcome the effects of gradual subsidence, the

formation of mud flats and their colonisation by plant and animal life, would necessarily be postponed until a condition of equilibrium had been attained. Once the bank of muddy silt is raised above low tide level, seedlings of *Avicennia officinalis* Linn. (Australian Grey Mangrove) establish themselves, and aid in the building up of a mud flat. The mud is generally black and of a coarse, sandy nature, punctured at frequent intervals by crab-holes (*see* Hedley, 1915, p. 46) and becoming foetid from the decay of various Algae, shellfish and drift material. These play an important part in providing humus and in aiding the building up of the flats.

THE VEGETATION OF THE TIDAL FLATS.

The tidal lands which come within the scope of the present paper are to be found chiefly in the upper reaches of the Iron Cove, Parramatta River, Lane Cove River, and Middle Harbour—all arms of Port Jackson; along the banks of Cook's and George's Rivers flowing into Botany Bay, and in the sheltered arms of Port Hacking. The area ranges from 33° 50' to 34° 5', S. Lat. and extends from Port Jackson south of Sydney for a distance of about sixteen miles (Text-fig. 1).

The area in Port Hacking to which the writer has given special attention is that of Cabbage Tree Creek, where an interesting series of changes is taking place, owing to the raising of the level of the saltmarsh by wind-blown sand.

Previous Investigations.

Extra-tropical mangrove and saltmarsh vegetation in Australia has been dealt with by but few writers. In his description of tidal woodland, Schimper (1903, p. 409) records the occurrence of the mangroves *Avicennia officinalis* Linn. (*Verbenaceae*) and *Aegiceras majus* Gaertn. (*Myrsinaceae*) on the coast of New South Wales. This record is briefly descriptive and deals with the nature of the viviparous seedlings in the two genera (p. 400).

Hedley (1915, pp. 44-46) records the same species for Port Jackson and gives Wilson's Promontory in Victoria as the most southerly station in Australia for *Avicennia officinalis*.

In a preliminary account of the coastal vegetation near Adelaide, Osborn (1914, pp. 584-586) records *Avicennia officinalis* as the only mangrove present. This writer also refers to the presence of *Suaeda maritima** mingling with the mangrove on its shoreward side. *Salicornia* swamps (with *Salicornia australis* Soland. and *S. arbuscula* R. Br.†) which are only subjected to occasional tidal inundation, are found on the shoreward side of the mangrove. Zonation is recorded in these swamps, the zones being as follows: "(1) *Salicornia*; (2) *Salicornia* and *Samolus repens*; (3) *Samolus repens* and *Sporobolus virginicus*; (4) *Sporobolus*, *Spergularia*, etc."

Western Australian extra-tropical mangrove has been dealt with by Dr. C. H. Ostenfeld (1918, pp. 1-12). This writer recognises three shore line formations on the coast of Western Australia, south of the Tropic.

1. MANGROVE FORMATION.
2. SANDY SEA SHORE FORMATION.
3. SALT PAN FORMATION.

*See reference to Paulsen below.

†Recent investigations by Black (1919) into South Australian *Salicornieae* point to the plant hitherto known as *Salicornia arbuscula* being in reality *Arthrocnemum arbuscula*.

Avicennia officinalis is recorded as being the only woody plant in Western Australian mangrove formation south of the Tropic.

Ostenfeld refers to the mingling of the succulent halopyte *Suaeda* with mangrove at its higher levels. Paulsen's work on Western Australian *Chenopodiaceae* points to this being a new species, viz., *Suaeda australis* (1918, p. 65). The absence of other plants amongst the mangrove is attributed to the great force of the tides which reach a velocity of ten to twelve knots in places (Ostenfeld, 1918, p. 8).

In the salt pan formation, Ostenfeld describes the plant covering as being chiefly cushion forming *Chenopodiaceae*, species of *Arthrocnemum*, also *Salicornia australis* and *Samolus junceus* R. Br., etc. (Ostenfeld, 1918, Pl. 1, 2.)

In a recent paper on saltmarsh vegetation in the Port Jackson district, N.S.W., Hamilton (1919, p. 470) refers to three plant formations in the local estuarine flora. These are:—

1. The TIDE-FLOODED ZONE, with *Avicennia officinalis* and *Salicornia australis* as dominants.
2. The DRY SALT PLAIN, with sparse vegetation and scattered detritus mounds.
3. The FLUVIAL ZONE, separated from the former by a band of *Casuarina glauca* Sieb. (the Swamp Oak), and marking the encroachment of fresh water conditions upon brackish and saline.

BOTANICAL FEATURES OF A TYPICAL TIDAL MARSH NEAR SYDNEY.

The vegetation of a typical tidal marsh in the neighbourhood of Sydney, is made up of two plant formations:—

1. An outer TIDAL WOODLAND or MANGROVE FORMATION. (Pl. xxvi., Photo 1).
2. An inner SALTMARSH FORMATION.

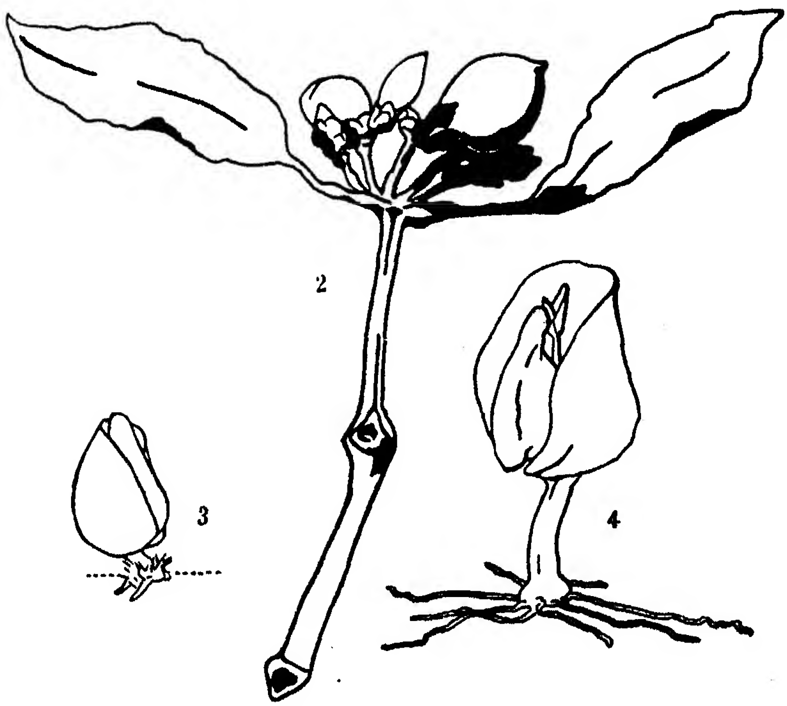
In mangrove formation, there can be recognised but one plant association, comprising *Avicennia officinalis* and *Aegiceras majus*, while in saltmarsh formation there are generally two distinct associations, the outer in which *Salicornia australis* and *Suaeda australis** are usually co-dominants, and an inner, which marks the landward boundary of the marsh, is an almost closed association of the rush *Juncus maritimus* Lam.

Pioneer Phase of a typical tidal Marsh.

In the pioneer phase, the typical tidal marshes around Sydney are colonised by viviparous seedlings of *Avicennia officinalis* drifted up by the tides. The seedlings are provided with a pair of large fleshy cotyledons, surmounting a short, blunt hypocotyl (Text-figs. 2-4). They establish themselves readily, or are bound down by mats of the Alga *Cladophora* until the first roots have made their appearance. *Avicennia* grows on the outermost limits of the formation. It reaches a height of from fifteen to thirty feet and presents a striking appearance owing to the varying angles at which the trunks are bent to the foreshore (Pl. xxvii., Photo 2) and to the countless asparagoid pneumatophores which project vertically out of the mud (Pl. xxvi., Photo 3). These pneumato-

* Ove Paulsen's work on Chenopodiaceae (1918, pp. 55-66) indicates that the species of *Suaeda* in Australia hitherto known as *S. maritima* should be known as *S. australis* R.Br.

phores spring from long horizontal roots which radiate from the base of the tree, and are to be found at no great depth below the surface of the mud (Text-fig. 5, and Pl. xxix., Photo 8). This horizontal growth of the root system of *Avicennia* helps to consolidate the mud and prepare it for later colonisers.

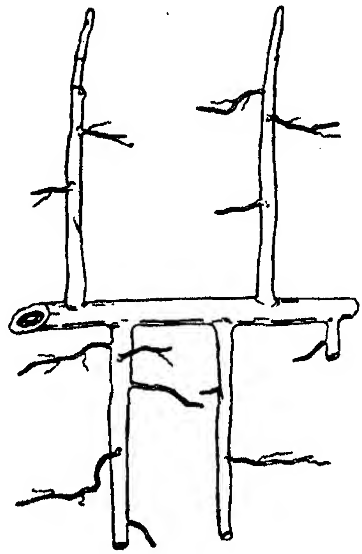


Text-figs. 2-4. Viviparous seedlings of *Avicennia officinalis*.

2. Attached to parent plant and still enclosed within pericarp. 3. After rupture of pericarp and showing establishment of seedling on mud; note circlet of hairs at base of hypocotyl and first roots projecting. 4. Later stage of establishment, where numerous roots have developed at base of hypocotyl and are taking up horizontal position on mud.

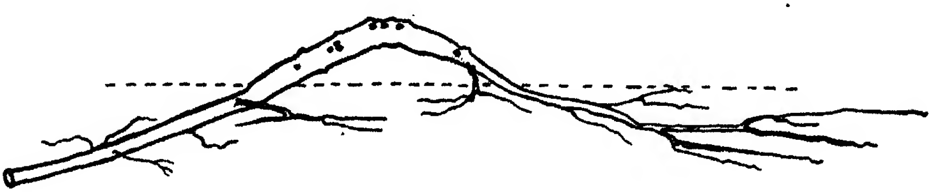
Aegiceras majus is by no means as constant a feature of mangrove formation near Sydney as is *Avicennia officinalis*. The former apparently reaches its southernmost limits on the coast of New South Wales, possibly at Cabbage Tree Creek, Port Hacking, to be described later. *Aegiceras* occupies the innermost limits of mangrove formation and is in striking contrast to *Avicennia officinalis* (Plate xxvii., Photo 4). It grows erect, and is, at most, a tall shrub (Pl. xxviii., Photo 5). Its average height near Sydney is about six feet. Its glossy green foliage stands out vividly against the grey-green of *Avicennia*, as do also its red, tannin-bearing branches against the ashy grey, lichen-coated trunks of *Avicennia*. The leaves of *Aegiceras majus* are remarkable in early morning for

their coating of glistening salt crystals which are secreted by special complex glands (Solereder, 1908, 510). During the day, this fine layer of salt is swept away by on-shore breezes.



Text-fig 5. Pneumatophores of *Avicennia officinalis* showing relationship to the general root system.

The root system of *Aegiceras* does not extend for such great distances from the plant as does that of *Avicennia*. The roots possess no special pneumatophores but occasionally run for a short distance over the surface of the mud, or rarely, are raised into knee-like projections (Text-fig. 6). In this *Aegiceras* more closely resembles certain tropical mangroves, e.g. *Bruguiera* (Schimper,



Text-fig. 6. Part of root system of *Aegiceras majus* showing knee-like projections above mud level.

1903, p. 401). A special air-storing tissue is developed in the roots, connecting with large pneumathodes.

Of the viviparous seedlings of *Aegiceras*, Schimper says (1903, p. 400) "The seedlings of *Aegiceras* are curved like horns, and are smaller than those of the *Rhizophoraceae;* they remain enclosed in the thin pericarp of the fruit." (*See* Pl. xxviii., Photo 6 of this paper).

The writer has observed various stages in the emergence and establishment of the young seedling of *Aegiceras*. The seedling drops to the mud, still enclosed within the thin brown pericarp of the fruit. It is not in such an advanced state as that of *Avicennia*. The hypocotyl is pronounced, green in colour and curved at the end from which the radicle is destined to develop. A pair of small green cotyledons are just discernible at the tip of the hypocotyl. After a time the pericarp splits and the curved portion of the hypocotyl elongates towards the mud (Text-figs. 7-9). The hypocotyl continues to grow and at length a thin colourless primary root penetrates the mud, from which secondary roots are given off later. In the meantime the pericarp has split again to

Text figs. 7-10. Various stages in the establishment of the viviparous seedling of *Aegiceras majus*.

allow the escape of the cotyledonary region and the plumule. The seedling becomes erect and the short epicotyl and first true leaves make their appearance the only trace of the original curvature of seedling being found where the root enters the mud. With the elongation of the seedling, the pericarp is carried some distance above the mud (Text-fig. 10), but after a time it decays and drops to the ground.

The development of saltmarsh commences almost simultaneously with that of mangrove. Here *Salicornia australis* Soland. is the pioneer plant and often establishes itself to the exclusion of other species. In parts of the George's River and Botany Bay large areas are occupied by pure Salicornietum (Hedley, 1915, p. 46).

It is more generally found, however, that *Suaeda australis* follows *Salicornia* closely and becomes a co-dominant with the latter in the initial stages of Saltmarsh.

In order to understand the conditions which exist on the majority of tidal flats near Sydney, it is necessary to study the vegetation over a continuous period of time. It is only thus that developmental phases may be recognised and the true limits of the association established. The writer recognises two plant associations in salt marsh formation near Sydney:—

(i.) An outer mixed saltmarsh association corresponding to the "mixed salting" of British investigators (Carey and Oliver, 1918; Tansley, 1911). Since *Salicornia australis* is the dominant species here, the writer will refer to this association as *Salicornietum.*

(ii.) An inner almost pure association of *Juncus maritimus* which usually marks the boundary between the marsh and land flora—the *Juncetum.*

i. *Salicornietum.*

On young *Salicornia* association it is possible to recognise at least three developmental phases or associes in Clement's sense (1916, p. 136). These appear to be associated with slight differences in level and are present as zoned bands which show a certain amount of overlapping. The lowest of these, which abuts on the mangrove formation is the (*a*) *Salicornia-Suaeda* associes, characterised by *Salicornia australis* Soland. and *Suaeda australis* R. Br. These low succulent shrubs are inundated by all tides and together with the pneumatophores of *Avicennia officinalis* play an important part in the building up of the marsh by acting as retainers of silt. (*b*). At a slightly higher level is an associes in which *Salicornia* and *Spergularia rubra* are developed equally with a number of low spreading perennial halophytes. The plants of this associes arranged in order of dominance are:—(i.) *Salicornia australis* Soland. (ii.) *Spergularia rubra* Camb. (iii.) *Suaeda australis* R. Br. (iv.) *Samolus repens* R. Br. (v.) *Mesembryanthemum tegens* F. v. M. (vi.) *Tetragonia expansa* Murr. (vii.) *Atriplex patula* L. (Introduced) (viii.) *Wilsonia Backhousii* Hook.

(*c*). *Sporobolus-Cynodon* associes which occupies a marginal position within the association and is of sward-like physiognomy (Pl. xxviii., Photo 7). The chief constituents are *Sporobolus virginicus* Humb. and Kunth., *Cynodon dactylon* Rich. and *Zoysia pungens* Willd., but as there is no strong line of demarcation between these latter associes, particularly where the slope is gradual, there is often a profuse mingling of perennial halophytes with the above-mentioned grasses. That these are developmental phases of the mature *Salicornia* association is shown clearly in old saltmarshes, where the level has been raised by silt accretion and a fairly uniform surface prevails. Here a mixed association of annual and perennial halophytes is found occupying the whole area between the inner *Juncetum* and the outer mangrove formation. In this mixed meadow-like association, *Salicornia* and *Suaeda* are predominant on the outer margin, since here seedlings have a better chance of establishing themselves. Where bare patches are found in this association owing to destruction of underlying vegetation by decaying detritus, algal mats, and the like (Harshberger, 1916) the pioneer colonist *Salicornia* is not slow in making its appearance. Thus, in

miniature, the history of the association repeats itself. The groups described above cannot be regarded as separate associations since they are all found mingling freely on old marshes where a fairly uniform surface level has been attained. Thus the term "Zonation" is not used in the same sense as by Yapp (1917, p. 68) in his description of the zoned vegetation of the marshes of the Dovey Estuary in Wales.

ii. *Juncetum Maritimi.*

The inner association of Saltmarsh formation near Sydney is of interest since it generally marks the landward boundary. It is often a pure association of *Juncus maritimus* Lam., but as Hamilton has shown, further species of *Juncus* (1919, pp. 480-482) and *Cladium junceum* (1919, p. 480) are often found. An interesting feature of this association is the presence in it of the "swamp oak" *Casuarina glauca* Sieb. These trees are generally found lining the banks of the marsh on the extreme outer limits of the *Juncetum* but occasionally they occur in local patches of slightly higher level within the association (Pl. xxxi., Photo 13). From superficial observation it is apparent that in the saltmarshes around Sydney differences in level, and consequently in drainage, play a large part in the delimitation of the plant associations. This should not form the subject of any generalisation, however, until careful mud analyses have been made and the results compared for different localities.

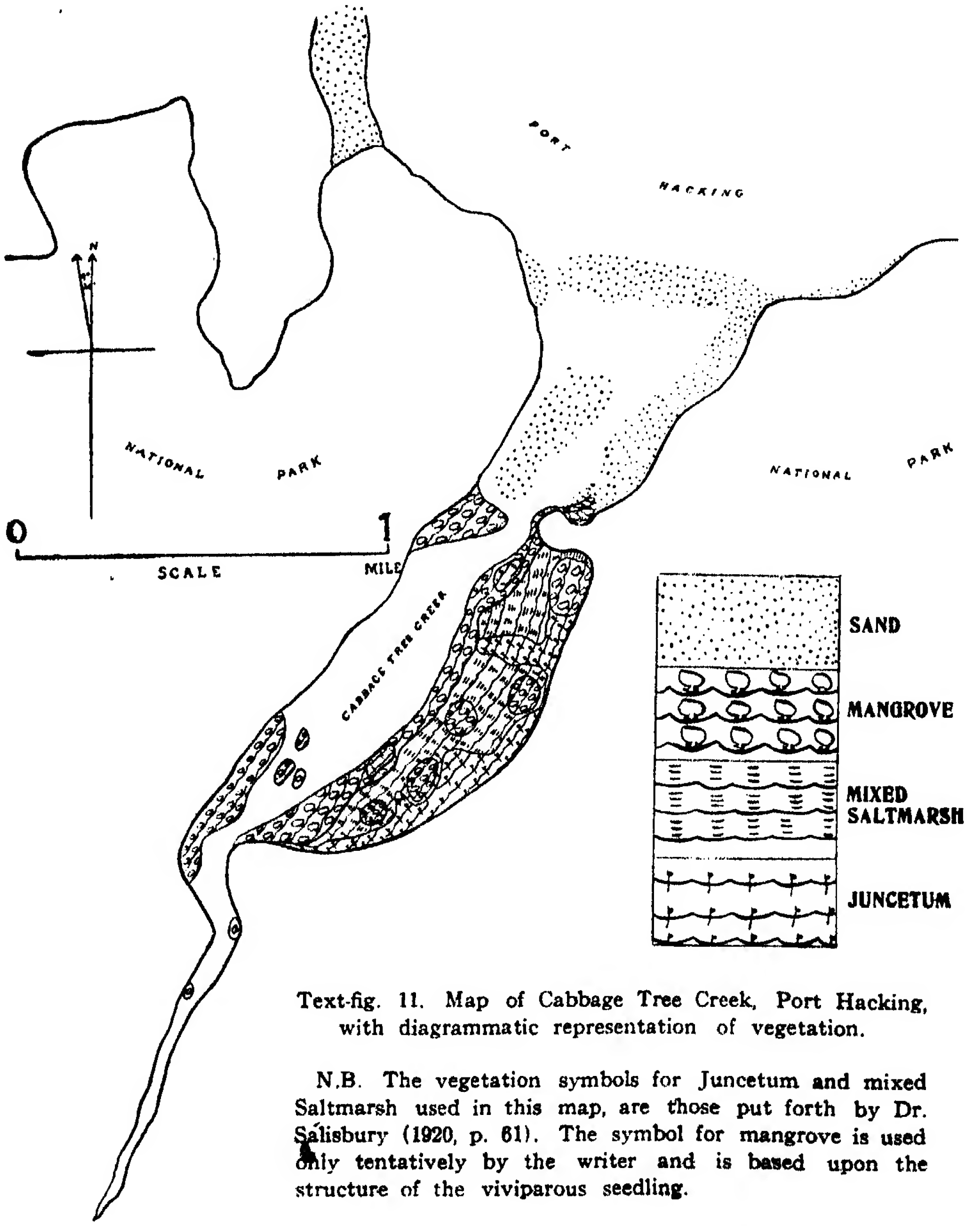
CABBAGE TREE CREEK, PORT HACKING.

Cabbage Tree Creek is a small stream entering Port Hacking on its southern side, at a distance of about two miles from the sea. The shore between the mouth of the creek and Port Hacking Point is indented by narrow sandy beaches of varying length (*See* Text-fig. 1). In a north-easterly direction from the Creek is Cronulla Beach, backed by high mobile sand dunes which extend across to Botany Bay. The entrance to Cabbage Tree Creek is partly blocked at low tide by sand spits and shoals (Text-fig 11). The larger sand spit projects from the southern shore and resembles in miniature, the sand bars which form a characteristic feature of the lagoons such as Deewhy, Narrabeen, etc., north of Port Jackson (Jose, Taylor and Woolnough, 1911, p. 136).

The main body of the creek may be divided into two parts, the upper fresh-water to brackish region which runs between gradually ascending sandstone slopes, and a lower, wider, basin-like region in which the water is distinctly saline. The southern shore of this lower portion of the creek is markedly concave, and it is here that an extensive tidal marsh has developed. Storm waters entering the creek are sufficient to keep the central channel clear, but since the creek narrows when nearing the mouth, its load of silt and detritus tends to be deposited upon the concave southern shore.

When the writer first visited Cabbage Tree Creek in 1916, a short strip of sandy beach abutted on the southern side of the creek entrance. At the point where this sandy beach reached the outlying mangrove at the mouth of the creek, young plants of *Avicennia officinalis* Linn. and *Aegiceras majus* Gaertn. were already showing signs of burial in drift sand. On the beach itself were recognisable two distinct zones, the strand, with clumps of *Salsola Kali* Linn. a little above high tide level, and small transitory hummocks occupied by *Senecio lautus* Soland. The second zone, that of larger hummocks or embryonic dunes, was characterised by an association of such plants as *Mesembryanthemum aequilaterale* Haw., *Scaevola suaveolens* R. Br., *Senecio lautus* Soland., *Spinifex*

hirsutus Labill., etc. Behind, the beach passed into stable or fixed dune region characterised by sclerophyllous scrub with *Acacia armata* R. Br., *Leucopogon richei* R. Br., etc. At the present day the beach shows a completely altered



Text-fig. 11. Map of Cabbage Tree Creek, Port Hacking, with diagrammatic representation of vegetation.

N.B. The vegetation symbols for Juncetum and mixed Saltmarsh used in this map, are those put forth by Dr. Salisbury (1920, p. 61). The symbol for mangrove is used only tentatively by the writer and is based upon the structure of the viviparous seedling.

appearance. A few scattered seedlings of *Salsola Kali* are establishing themselves upon the strand, but all that remains of the mobile dune zone are the decaying trails of *Spinifex hirsutus*, exposed by the action of the wind. Areas

occupied by mats of *Scaevola suaveolens*, over 6 feet in diameter, have ceased to exist.

The alteration of the vegetation covering this beach, suggests that the piling up of sand against the mangrove at the entrance to Cabbage Tree Creek is due to the activity of southerly gales rather than to the continuous and milder action of the prevailing north-easterly winds. (*See* Jose, etc., 1911, p. 136). It is possible, however, that the north-easterly winds carry a load of sand from the dunes behind Cronulla Beach and that a certain amount of this finds its way to the marshes at Cabbage Tree Creek.

The chief points of interest at Cabbage Tree Creek, at the present day, are the raising of the level of the tidal marsh by drift sand deposited on the surface of the mud, and the gradual blocking of the creek entrance by sand spits and shoals. The effect of both these changes is to lessen the amount of tidal inundation and to bring about alteration in the physical properties of the soil.

At the present day the tidal marsh at Cabbage Tree Creek presents a complex problem for solution. There does not appear to be any marked definition between mangrove and saltmarsh formations, and within the saltmarsh it is difficult to define the boundaries of the plant associations.

As on the marshes near Sydney, the outermost formation at Cabbage Tree Creek is mangrove in which *Avicennia officinalis* and *Aegiceras majus* are the only species. At the entrance to the Creek *Avicennia* and *Aegiceras* are being buried in drift sand (Pl. xxix., Photo 9). The area between the low tide level and the shore is occupied by saltmarsh which shows some striking differences from saltmarsh at Port Jackson. An interesting feature is the occurrence, throughout the saltmarsh, of groups of *Avicennia officinalis*. The innermost of these are only reached by the highest tides and may be regarded as being stranded. Their position in isolated areas within a newer formation is comparable with certain geological formations known as "inliers." These mangrove "inliers" indicate that rise in level of the mud surface has brought about the imposing of saltmarsh flora upon what was once entirely mangrove (Text-fig. 11 and Pl. xxxii., Photo 10).

Extensive areas at Cabbage Tree Creek are populated by dwarf Avicennia, (Pl. xxx., Photo 12) in which the main trunk is shortened and averages about one foot in height. The lateral branches are given off from this stocky trunk and take up a position parallel to the ground (Pl. xxx., Photo 11). Hamilton (1919, p. 470) records dwarf *Avicennia* at Homebush Bay, on the Parramatta River, and attributes their diminished form to dilution of tidal waters by fresh water from the inland drainage channels.

Warming (1909, p. 25) refers to the effect of temperature and the length of the vegetative season upon the external morphology of plants. He points out that dwarf forms occur when the vegetative season is short and the temperature low, as in arctic regions, or where high temperatures are combined with low water supply. Until a special investigation has been made of soil and temperature relations, the writer is not in a position to offer any reason for the occurrence near Sydney of localised areas of dwarf *Avicennia*. It is sufficient for the present to say that the writer regards this as a definite growth-form and in no way comparable with the general lowering of stature observed in mangroves as they occur farther from the tropics (Schimper, 1903, p. 409).

In 1916 the saltmarsh at Cabbage Tree Creek, Port Hacking, had passed through its pioneer phase, *Salicornia australis* and *Suaeda australis* being in full occupation of the mud immediately behind the mangrove, and in places penetrating through the mangrove to low water level. Other halophytes, such

as *Samolus repens* and *Spergularia rubra* had begun to spread over locally elevated patches.

At the present day there are but few species represented on this saltmarsh in comparison with the marshes of Port Jackson and George's River.

The plants recorded are:—

1. Salicornietum.
   Salicornia australis.
   Samolus repens.
   Sporobolus virginicus.
   Suaeda australis. (few isolated plants).
   Spergularia rubra. (few isolated plants).
2. Juncetum.
   Juncus maritimus, with occasional patches of *Casuarina glauca.*

Juncus maritimus does not occupy the landward fringe only, but shows encroachment upon the Salicornietum. Bands of *Juncus* have traversed the saltmarsh to the outer fringe of mangrove in places (Text-fig. 11; also Pl. xxxi., Photo 14).

It is in this invasion by *Juncus* of Salicornietum perhaps, that we can partly account for the paucity of species in the latter. It seems likely that the rate of raising of the level of the marsh is greater than that of establishment of species. The remarkable diminution in number of plants of *Suaeda australis* is doubtless owing to unfavourable conditions for establishment of seedlings. Also the formation of extensive meadow-like areas of *Samolus repens* (Pl. xxx., Photo 11) within the Salicornietum, is apparently helping to make conditions unfavourable for the establishment of other species on account of its close mat-like growth.

In this marsh there has been a hurrying over certain developmental phases, so that it is impossible to recognise any transitory groupings or associes within the associations.

Thus, in certain important features, the tidal marsh at Cabbage Tree Creek differs from the typical marshes of Port Jackson and Botany Bay. Here, owing to special conditions, one plant formation has been imposed upon another, and, within the second formation, one association (Juncetum) has invaded and arrested the development of the other (Salicornietum).

General Discussion.

The subsidence of a coastal region of youthful topography and the subsequent drowning of river valleys, has been, in part, responsible for the comparatively restricted nature of the tidal marshes in the neighbourhood of Sydney. The absence of any large, delta-forming rivers, has resulted in the limitation of saltmarsh to the silted bays and creeks found in the arms of drowned river valleys such as Port Jackson, Botany Bay and Port Hacking. These stations are always sheltered from the open sea and consequently the part played by certain Algae in their consolidation is not so important as is the case in certain British saltmarshes (Carey and Oliver, 1918, p. 170). Although the writer has made no attempt to deal with the algal vegetation of the saltmarshes near Sydney, it might not be out of place to record the occurrence of species of *Cladophora, Ulva* and *Enteromorpha,* the first of which is apparently not represented on the British saltmarshes (Carey and Oliver, 1918, p. 267). Leaves of the grass-wrack *Zostera,* washed up by tides, probably play a more important part in New South Wales in helping to consolidate and in adding organic matter to the mud. In the pioneer phases, saltmarsh near Sydney resembles

British and Eastern American marshes only in so far as some species of *Salicornia* is the first coloniser and is followed closely by *Suaeda*.

The British (Carey and Oliver, Howarth, Newman and Walworth, Yapp, etc.), Danish (Warming), French (Hill, Oliver) and American marshes (Ganong, Harshberger, Johnson and York) are characterised by the extensive development of grasses which enter into competition with other halophytes at an early stage. In certain Welsh marshes, *e.g.* on the Dovey Flats, the grass *Glyceria maritima* often replaces *Salicornia* as the pioneer coloniser. *Glyceria maritima* together with the grasses *Festuca rubra*, *Lepturus filiformis*, and *Agrostis alba*, and certain shrubby perennial halophytes, forms a compact turf which becomes of economic value for grazing (Yapp, etc., 1917, p. 72). On the American marshes the tall grass *Spartina glabra* (*stricta*) occupies the outermost fringe of the mud (Ganong, 1903, Johnson and York, 1915). In the marshes near Sydney, grasses do not play so important a part. They do not appear until a late stage in development and then are often represented by only one species—*Sporobolus virginicus*. Other grasses do occur with *Sporobolus*, however, the most important being *Zoysia pungens* and *Cynodon dactylon*. Hamilton records the occurrence of species of *Lepturus* and *Calamagrostis* (1919, p. 485) but does not make it clear as to whether these are to be regarded as true saltmarsh grasses.

The grass *Festuca rubra* appears to be a consistent feature of the British saltmarshes (Howarth, 1920; Newman and Walworth, 1919). From a comparative table given by Howarth to show zonation of vegetation on various British marshes, it is seen that while *Festuca rubra* or one of its sub-varieties is always present, its position in relation to the plant associations of the marsh varies for different localities. It is either entirely inside the limits of Juncetum, forming an association of its own, *e.g.* the Festucetum of the Dovey Flats (Yapp, etc., 1917, pp. 69-70) or it occurs as a co-dominant with *Juncus* at Holme-next-the-sea (Howarth, 1920, p. 221) or it plays an unimportant role on the outermost fringe of Juncetum (Tansley, 1911). The work of Newman and Walworth on the South Lincolnshire coast, indicates the presence of *Festuca rubra* amongst the marsh halophytes and even forming a special *Festuca-Salicornia* Zone (1919, p. 208).

Festuca rubra does not actually occur on the Sydney saltmarshes, but is generally found on the higher slopes immediately outside the limits of *Juncetum*. It occurs with non-halophytes such as species of *Plantago, Trifolium, Brisa*, and others in a region higher than Warming's "higher littoral meadow" (1909, p. 231). With increasing age and with elevation of surface level, it is possible that *Festuca* and other grasses may yet play an important role on the Sydney saltmarshes.

The depressions known as pans, which are such a constant feature of the British marshes (Carey and Oliver, 1918; Yapp, etc., 1917) are not found near Sydney. This may doubtless be accounted for in the comparative youth of the tidal flats near Sydney. There are shallow bare depressions however, in which water remains for some time after the tides have receded. These more closely resemble the salt marsh pools described by Harshberger (1916) for the New Jersey coast.

SUMMARY.

1. Physiographic features of the coast in the neighbourhood of Sydney are briefly dealt with in relation to the formation of sheltered tidal flats.
2. The two plant formations of these tidal flats are discussed and an account of their developmental phases given.

TABLE COMPARING VEGETATION OF TIDAL MARSHES.

ENGLAND. Types of British Vegetation. Tansley (1911).	WALES. Dovey Estuary. Yapp (1917).	U.S.A. Bay of Fundy, New Brunswick. Ganong (1903).	U.S.A. Cold Spring Harbour, Long Island. Johnson & York (1915).	AUSTRALIA. Sydney, N.S.W. Collins (1921).
1. SALICORNIETUM.	1. SALICORNIETUM.	1. SPARTINETUM.	Mid-littoral Belt.	A. Mangrove Formation.
Salicornia Europaea.	2. GLYCERIETUM.	*Spartina glabra.*	1. SPARTINETUM.	*Avicennia officinalis.*
Glyceria maritima.	*Glyceria maritima.*	2. SALICORNIETUM.	*Spartina glabra.*	*Aegiceras majus.*
Triglochin maritimum.	*Salicornia Europaea.*	*Salicornia herbacea.*	*Lilaeopsis lineata.*	B. Saltmarsh Formation.
Aster Trifolium.	3. ARMERIETUM.	*Suaeda maritima.*	Upper Littoral Belt.	1. SALICORNIETUM.
2. GENERAL SALTMARSH ASSOCIATION.	*Armeria maritima.*	*Spergularia borealis.*	2. MIXED SALTMARSH.	i. Salicornia-Suaeda Associes.
Spergularia marginata.	*Glyceria maritima.*	*Atriplex hastatum (patulum).*	*Spartina patens.*	*Salicornia australis.*
S. salina.	*Festuca rubra.*	3. STATICETUM.	*Suaeda maritima.*	*Suaeda australis.*
Aster Tripolium.	*Lepturus filiformis.*	*Statice limonium.*	*Salicornia Europaea.*	ii. Salicornia-spergularia Associes.
Artemisia maritima.	*Glaux maritima.*	*Plantago maritima.*	*Juncus Gerardi.*	*Salicornia australis.*
Statice limonium.	*Triglochin maritimum.*	*Spartina patens.*	*Scirpus Americanus.*	*Spergularia rubra.*
Armeria maritima.	4. FESTUCETUM.	*Puccinellia maritima.*	*S. robustus.*	*Samolus repens.*
Plantago maritima.	*Festuca rubra.*	*Festuca ovina.*	*Distichlis spicata.*	*Suaeda australis.*
Atriplex portulacoides.	a. Lower.	*Juncus Gerardi.*	*Salicornia ambigua.*	*Mesembryanthemum tegens.*
Salicornia Europaea.	*Armeria maritima.*	*Triglochin maritimum.*	*Atriplex patula.*	*Tetragonia expansa.*
S. radicans.	*Juncus Gerardi.*	*Hordeum jubatum.*	*Limonium Carolinianum*	*Atriplex hastata (patula).*
Suaeda maritima.	*Lepturus filiformis.*	*Glaux maritima.*	*Plantago decipiens.*	**Wilsonia Backhousii.*
Triglochin maritimum.	*Glaux maritima.*		*Scirpus nanus.*	iii. Sporobolus-Cynodon Associes.
Glyceria maritima.	*Plantago coronopus.*		*Triglochin maritimum.*	*Sporobolus virginicus.*
3. GLYCERIETUM.	*Triglochin maritimum.*		*(*Atriplex arenaria*).	*Cynodon dactylon.*
Glyceria maritima.	*Aster Tripolium.*		*(*Iris versicolor*).	*Zoysia pungens.*
Statice Limonium.	b. Upper.		*(*Samolus floribundus*).	Other perennial halophytes.
Armeria maritima.	*Agrostis alba coarctata.*		*(*Spergularia marina*).	2. JUNCETUM.
Suaeda maritima.	*Plantago coronopus.*		*rare.	*Juncus maritimus.*
4. JUNCETUM.	*Juncus Gerardi.*			*Casuarina glauca.*
Juncus maritimus.	*Armeria maritima.*			
Oenanthe Lachenalii.	*Triglochin maritimum.*			
Glaux maritima.	5. JUNCETUM.			
Plantago maritima.	*Juncus Gerardi.*			
P. coronopus.	*Festuca rubra.*			
Agropyrum pungens.	*Agrostis alba coarctata.*			
Agrostis palustris.	*Cochlearia officinalis.*			
Festuca rubra.	*Spergularia marginata.*			
	Aster Tripolium.			
	Triglochin maritimum.			

3. The first and outermost is mangrove formation characterised by two species, *Avicennia officinalis* and *Aegiceras majus*.
4. The second, inner formation is saltmarsh, in which two associations are recognised, (*a*) *Salicornietum*, (*b*) *Juncetum*.
5. Developmental groups or associes of Salicornietum are often found in zoned arrangement according to slight differences in level.
6. With accretion and attainment of uniform surface level, these associes mingle to find ultimate expression in mature *Salicornia* association.
7. Special conditions at Cabbage Tree Creek, Port Hacking, are described. Here, drift sand has been raising the level of the marsh for some years and has brought about the imposing of one formation upon another. At the present day the marginal association of the saltmarsh—*Juncetum*—is invading Salicornietum, which consequently shows signs of arrested development.
8. The occurrence of a dwarf-form of *Avicennia officinalis* is recorded for Cabbage Tree Creek, Port Hacking.
9. In a general discussion and table the vegetation of the tidal flats near Sydney is compared with those of Great Britain and other countries.

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EXPLANATION OF PLATES XXVI.-XXXII.

For the photographs illustrating this paper the writer has to thank Mr. A. Musgrave, Entomologist, Australian Museum, and Mr. D. A. Pritchard, B.Sc. Text-figures 2 to 5 were prepared by Miss Bennett, Teachers' College, Sydney.

Plate xxvi.

Photo 1. Mangrove formation *(Avicennia)* at high tide. Middle Harbour, Port Jackson.

„ 3. Close view of *Avicennia officinalis* showing pneumatophores. Middle Harbour, Port Jackson.

Plate xxvii.

Photo 2. Interior of Mangrove formation at Port Hacking, showing distorted branches of *Avicennia officinalis* and pneumatophores.

„ 4. Cabbage Tree Creek, Port Hacking showing extensive development of *Aegiceras majus* on inner limits of Mangrove formation. Ground vegetation of *Salicornia* and *Samolus* beneath mangrove.

Plate xxviii.

Photo 5. *Aegiceras majus* Port Hacking. Pneumatophores have arisen from a neighbouring *Avicennia.*

„ 6. *Aegiceras majus* with cluster of viviparous fruits.

„ 7. Junction of *Sporobolus-Cynodon* Associes and *Salicornia-Samolus* Associes within Salicornietum at Middle Harbour, Port Jackson. Note: *Samolus* replaces *Spergularia* in this region as co-dominant with *Salicornia.*

Plate xxix.

Photo 8. *Avicennia officinalis* (tree) and low bushes of *Aegiceras majus* near mouth of Cabbage Tree Creek, Port Hacking. Note horizontal roots bearing pneumatophores uncovered by action of tides. Outskirts of encroaching sand are seen to the left.

„ 9. *Avicennia officinalis* and *Aegiceras majus* being buried in drift sand. Dwarf *Avicennia* in right middle distance. Cabbage Tree Creek, Port Hacking.

Plate xxx.

Photo 11. Group of old trees of *Avicennia officinalis* near mouth of Cabbage Tree Creek, Port Hacking. Note pneumatophores and dwarf *Avicennia* beneath trees. Foreground occupied by sward of *Samolus repens* with a few clumps of *Juncus maritimus* Right foreground shows bush of *Aegiceras majus.*

Photo 12. Dwarf-growth of *Avicennia officinalis. Samolus repens* in foreground.

Plate xxxi.

Photo 13. Juncetum *(Juncus maritimus)* with group of young *Casuarina glauca* advancing upon Salicornietum at Cabbage Tree Creek, Port Hacking.

„ 14. Band of *Juncus maritimus* passing through Salicornietum to inner limits of mangrove.
Avicennia officinalis on right foreground and regular line of *Aegiceras majus* in middle distance.

Plate xxxii.

Photo 15. Juncetum with old decaying trunks of *Casuarina glauca* at Cabbage Tree Creek. Mangrove "inlier" in right background.

„ 10. Mangrove "inlier" *Avicennia* at Cabbage Tree Creek, Port Hacking. Ground vegetation of *Salicornia*, *Samolus* and *Sporobolus*.

REVISION OF THE AMYCTERIDES.

Part vii. *Hyborrhynchus* and Allied Genera

By Eustace W. Ferguson, M.B., Ch.M.

The present part deals with a small group of genera which present affinities both with the *Acantholophus-Cubicorrhynchus* and with the Euomid complexes. The genera here considered include *Hyborrhynchus* and *Anascoptes* and two new genera proposed for species formerly included in *Hyborrhynchus*.

These four genera possess one feature in common, in that the elytra are so shaped at the base that the distance between the ends of the third interstices is equal in width to the base of the prothorax. The only other genus known to me possessing this character is *Dialeptopus,* which is very dissimilar in other respects from *Hyborrhynchus* and its allies.

In its general appearance *Hyborrhynchus* shows considerable resemblance to *Acantholophus,* while *Anascoptes* is more suggestive of the next group—the *Euomides.* Both these genera have the clypeal plate not deeply sunken but more or less prominently placed at the apex of the rostrum, a character found in most Euomid genera. In the remaining two genera the clypeal plate is contained between the anterior ends of the lateral ridges, though not as deeply sunken as in most of the genera already dealt with in this revision.

The group seems thus to form a connecting link between these genera and the *Euomides,* if indeed these last can be regarded as a separate division of the subfamily.

In its distribution the group appears essentially western and is mostly found in the South West corner of the continent, though one species extends as far east as Sydney.

The following table will enable the four genera to be distinguished.

Table of Genera.

1	(6)	Upper surface of rostrum deeply excavate.	
2	(5)	Scrobes extending back to eyes.	
3	(4)	Prothorax with lateral margins spinose	Hyborrhynchus
4	(3)	Prothorax elongate, lateral margins not spinose	Neohyborrhynchus
5	(2)	Scrobes ending at some distance in front of eyes	Parahyborrhynchus
6	(1)	Upper rostral surface not deeply excavate, at most feebly concave at base	Anascoptes

Hyborrhynchus.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 295.

Small, elongate, spinose species, in general facies resembling small species of *Acantholophus.*

Head with supraorbital tubercles and generally frontal granules or tubercles. Rostrum short, about as wide as head, deeply excavate above, with the clypeal plate more or less exserted; with a prominent tubercle on each lateral margin, and in most species with a pair of large basal tubercles, corresponding in position to the internal ridges. Antennae slender; scape long. Eyes rotundate or subrotundate, rather coarsely faceted. Prothorax shaped as in *Acantholophus,* the apical margin more or less produced above; without ocular lobes; disc with median and sublateral areas separated by the submedian rows of tubercles; lateral margins tuberculate, the tubercles either one or two in number, outwardly projecting. Elytra elongate, narrow in ♂, broader in ♀; apex more or less deeply emarginate and bimucronate; base contained between the advanced ends of the third interstices; disc striate punctate with two or three rows of tubercles, the third row sometimes reduced to a single infrahumeral tubercle or spine. Venter more or less flattened in ♂, convex in ♀; the intermediate segments moderately long; the apical segment without excavation. Legs moderately long and slender; tarsi of moderate length.

Though in general appearance resembling the smaller species of *Acantholophus,* the present genus may be readily distinguished by the relation of the bases of the prothorax and elytra. The arrangement of the rostral tubercles is also different, the large basal pair not being found in *Acantholophus.* The presence of these is however not absolutely constant in *Hyborrhynchus,* and the arrangement of the head and rostral tubercles affords good specific features.

The species are very similar in appearance but are all readily separated, partly on the characters of the above-mentioned tubercles, but partly also on the arrangement of the lateral prothoracic and of the elytral tubercles.

History.—The genus *Hyborrhynchus* was proposed in 1865 by William Macleay for the reception of one species previously placed in *Acantholophus*—*coenosus* Bohem.—and of three new species—*furcatus, maculatus* and *rugosus.* Subsequently, in 1866, Macleay added 4 further species—*mastersi, prodigus, crassiusculus* and *bicornutus.*

H. coenosus Bohemann was originally described (Schonh. Gen. Spec. Curc., vii. (1), 1843, p. 80) under the genus *Amycterus.* In 1846 Schonherr included it in *Acantholophus,* then first formally described (Mantissa secunda Curc., p. 57), though the species is not mentioned by name, only the number (50) of its place in the original publication being given. The species was also included in the table of the genus *Acantholophus* given by G. R. Waterhouse (Trans. Ent. Soc., N.S., iii., 1854, p. 2).

This species I would now select as the genotype of *Hyborrhynchus,* not because it is the earliest described species referable to the genus, but because Macleay in describing *H. furcatus* (the first species described by him) based his description on the sexes of two species, one of them being the species (*maculatus*) next in order. The question of the allotment of these names is discussed under *H. furcatus.*

The third species (*rugosus*) is here made the type of a new genus.

Of the 4 species added by Macleay in 1866, two—*mastersi* and *crassiusculus* —are now removed to a new genus.

Only one species has been described of recent years—*aurigena* Blackb. (Trans. Roy. Soc. S. Aust., 1899, p. 89). This I have already removed to *Cubicorrhynchus* (Proc. Linn. Soc. N.S. Wales, 1916, xli., part 3, p. 452). One new species is added in the present paper, making a total of 6 species at present known. *Acantholophus convexiusculus* Macl. was provisionally referred to *Hyborrhynchus* in the previous part of this revision. It is here referred to a

new genus, proposed to receive it and the species—*H. mastersi* Macl., and *H. crassiusculus* Macl.—mentioned above.

Table of Species.

1 (10) Basal rostral tubercles strongly developed, acute.
2 (7) Supraorbital tubercles long, more or less acute.
3 (6) Prothorax with the tubercle anterior to subapical constriction not abnormally developed.
4 (5) Postero lateral tubercle of prothorax present .. .. .. *H. coenosus* Bohem.
5 (4) Postero-lateral tubercle absent .. .. *H. prodigus* Macl.
6 (3) Prothorax with a long spine anterior to subapical constriction *H. aculeatus* n. sp.
7 (2) Supraorbital tubercles small, obtuse.
8 (9) Both sexes with a median pale vitta on elytra bifurcate at edge of declivity .. .. *H. furcatus* Macl.
9 (8) Male with several narrow vittae, female maculate .. .. *H. maculatus* Macl.
10 (1) Basal rostral tubercles small, granuliform .. .. *H. bicornutus* Macl.

Note. I have followed the usual spelling of the name of the genus. Macleay however used *Hyborhynchus*. The emendation appears to have been made by Pascoe and is adopted in Masters' Catalogue.

HYBORRHYNCHUS COENOSUS Bohem.

Amycterus coenosus, Bohemann, Schonh. Gen. Spec. Curc., vii., (1), 1843, p. 80; *Hyborhynchus coenosus,* Macl., Trans. Ent. Soc. N.S. Wales, i., 1865, p. 297.

♂. Elongate, narrow; clothed with rather dense brownish subpubescence.

Head with frontal tubercles small; supraorbital tubercles moderately long, erect. Rostrum excavate above; lateral margins triangularly raised in a short tubercle; basal tubercles large and erect. Antennae with first joint of funicle slightly shorter than second. Eyes rotundate. Prothorax slightly produced above, without evident ocular lobes; disc flattened; median area depressed, obsoletely granulate; submedian tubercles small, noduliform, irregularly set, the median ones more outwardly placed; lateral margins bituberculate, the tubercles elongate, trianguliform, the anterior longer than the posterior.

Elytra parallel-sided, with apex strongly bimucronate; base with forward projecting tubercles on the first and third interstices; punctures obscured by clothing; with two rows of tubercles, situated on the third and fifth interstices; first row with a large conical tubercle or spine at humeral angle, followed by about six tubercles, the anterior ones small and noduliform, the posterior three or four conical and spiniform, the last much the largest and projecting back over the declivity; second row on fifth interstice about 5 in number, forming the lateral margin, the first tubercle large and spiniform, the second smaller but spiniform, the others becoming progressively larger, the last very long, situated on a lower level than the apical tubercle of the first row; seventh interstice with a small infra-humeral tubercle.

Venter flat, densely covered with brown depressed clothing. Legs elongate, slender.

♀. Larger, with wider elytra in comparison with prothorax; head and prothorax similar; elytral tubercles slightly smaller; venter feebly convex.

Dimensions: ♂. 11 x 4 mm.; ♀. 13 x 4.5 mm.

Hab.—Western Australia: Swan R. (Bohemann), King George Sound (Macleay). The locality, Swan R., given in the original description is probably equivalent to Swan River Colony.

The frontal tubercles are hardly more than granules and may be obsolete.

The species is nearest to *H. prodigus* Macl., but may be distinguished by the postero-lateral prothoracic spine being developed, and by there being only two rows of tubercles on the elytra.

HYBORRHYNCHUS PRODIGUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1866, p. 333.

♂. Elongate, narrow; densely clothed with greyish subpubescence, elytra with a median brown vitta, maculate with white, sides of prothorax bivittate, and lower margin of elytra vittate with white.

Head similar to *H. coenosus*, but supraorbital crests longer and more acute. Rostrum with marginal and basal tubercles also much longer and more acute, the basal ones farther apart. Prothorax similar; submedian tubercles narrower and more erect; lateral margins with a single anterior spine, the posterior obsolete.

Elytra similar to *H. coenosus;* punctures more regular and distinct; third interstice with a row of about nine tubercles, the humeral and last two or three acutely spiniform, the apical ones long, projecting backwards, the others smaller but conical and more distinct than in *H. coenosus;* fifth interstice with six tubercles somewhat more slender and acute than in *H. coenosus;* seventh interstice with a moderately large infra-humeral spine, followed by a row of three small spiculiform tubercles.

Venter with brown clothing and a median vitta of white. Legs long and slender.

♀.—Head, rostrum and prothorax similar. Elytra noticeably broader with apical mucronations nearer and not divergent; tubercles slightly smaller. Venter gently convex.

Dimensions: ♂. 10.5 x 4 mm.; ♀. 11.5 x 5 mm.

Hab.—Western Australia: King George Sound.

The differences between this species and its nearest ally—*H. coenosus*—are given under that species. It might be added that the supraorbital and rostral spines are longer than in *H. coenosus.*

The above description was drawn up from the Macleay Museum specimens, which are probably the types.

HYBORRHYNCHUS ACULEATUS, n. sp.

♂. Small, elongate, very strongly spinose. Black; clothing abraded.

Head somewhat flattened in front; frontal tubercles absent; supraorbital tubercles long, acute, erect. Rostrum concave above; marginal tubercles rather short, but erect and acute; basal tubercles widely separated, long and acute.

Prothorax strongly produced over head; submedian row with the first tubercle produced as a long spine projecting far over the head, the remaining tubercles small but conical, not quite in a straight line; lateral margins with two strong outwardly projecting spines, the anterior in front of the subapical constriction, with a strong forward inclination, the second representing the antero-lateral spine, with a slighter forward inclination; two small granules present posterior to middle.

Elytra narrow, widest anterior to middle; base with forward projecting spines at the ends of the first and third interstices; apex with a strong spine on each side; punctures moderately large and deep; granules not traceable; with two rows of tubercles, the first row on the third interstice consisting of

3-4 small spiniform granules extending backwards from the humeral spine, followed by two or three short conical spines with a long acute spine on the edge of the declivity; second row on fifth interstice consisting of 5 spines, the first large, acute, projecting outwards and somewhat forwards, the following 3 smaller but acute, the apical one very long and acute, situated at a lower level than apical tubercle of first row; seventh interstice with a strong infra-humeral spine.

Venter flattened; more or less densely covered with brown depressed clothing, with a narrow median white vitta. Legs simple. *Dimensions*: ♂. 8 x 3.5 mm.

Hab.—Western Australia. Described from a single male, not in too good preservation, in the Macleay Museum collection.

This species differs widely from any of the other members of the genus and perhaps should be separated generically; the arrangement of the head and rostral tubercles is however similar. *H. aculeatus*, though the smallest species known, has longer spines than any of the others. It may be recognised by the long spines projecting from the prothorax over the head, and by the long spine on the side of the prothorax, in front of the subapical constriction.

HYBORRHYNCHUS FURCATUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 296.

♂. Narrow, elongate. Black; clothing dusky, inconspicuous, median line of elytra with a mixed white and brown vitta, furcate at declivity and extending on to inner sides of the apical tubercles of first row.

Head with frontal and supraorbital tubercles small and noduliform, not quite in a straight line across the head, the supraorbital somewhat larger than the frontal. Rostrum widely excavate above; the lateral margins raised, angulate, but hardly tuberculate; basal tubercles large, erect, conical, moderately closely approximated. Antennae with second joint of funicle longer than first.

Prothorax slightly produced over the head; submedian tubercles noduliform, not in single series, partially united to form a low, irregular ridge on either side of median area, the posterior pair rather strong and projecting backwards; lateral margins bituberculate, the anterior tubercle strong, subtriangular, the posterior smaller and obtuse.

Elytra parallel-sided; base with short, forward projections at the ends of the first and third interstices; apex emarginate, briefly mucronate on each side; sculpture somewhat confused, punctures moderately large, less regular than in *H. maculatus*; with three rows of tubercles; first row with 7, the basal one large and conical, situated at humeral angle, the intermediate ones erect, obtuse nodules, becoming larger posteriorly, the apical tubercle large and acute; second row with 5-6 strong conical tubercles, the first and the last two larger than the others, the apical tubercle reaching a lower level than that of first row; seventh interstice with a strong, conical, infra-humeral tubercle, followed by a row of 3-4 smaller tubercles. [Venter missing]. Legs simple.

♀. With clothing as in ♂, but median bifurcate vitta even more strongly marked. Elytra broader with apex more widely emarginate; tubercles smaller and more obtuse. Venter rather feebly convex; moderately densely clothed with brown, with scattered whitish decumbent setae.

Dimensions: ♂. 11 x 4 mm.; ♀. 12 x 5 mm.

Hab.—Western Australia: King George Sound.

The above description of the male is taken from a specimen in my own collection. The male described by Macleay, now in the Macleay Museum, is not the same species as the female described, but belongs to the next species—*H. maculatus* Macl. It may be that the male should be regarded as the holotype of the species, in which case the name *maculatus* would fall as a synonym of *furcatus,* while a new name would be required for the present species. I do not propose to follow this procedure as it is abundantly evident from the specific names, and also from his comments, that Macleay distinguished the two species on the differences between the two females, and I would suggest that this sex be regarded as the holotype of *H. furcatus,* thus preserving both names.

The two species are closely allied but the clothing is quite distinct, and the general sculpture is rougher in *H. furcatus*.

Both species may be distinguished from the other members of the genus by the small supraorbital tubercles. They are also separable from the other species on the form of the submentum. In *H. furcatus* and *H. maculatus* the buccal emargination is straight whereas in the other species there is a strong tongue-shaped median lobe projecting into the aperture from the submentum. This lobe occurs also in *Anascoptes* and in other widely separated genera, and its significance is uncertain. The submentum was not examined in *H. aculeatus*.

HYBORRHYNCHUS MACULATUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 297.

♂. Small, narrow. Clothed with dark brown pubescence, prothorax with a median golden brown vitta, sides with a dense white vitta above; elytra with golden brown vittae between the rows of tubercles and on lateral interstices, the lowest interstice with a white vitta, declivity with a single, mainly white, vitta on each side.

Head with tubercles as in *H. furcatus*; rostrum similar but with external margins less strongly angulate, and basal tubercles slightly smaller. Antennae with the first two joints of the funicle subequal.

Prothorax much as in *H. furcatus;* submedian tubercles smaller, not conjoined; lateral tubercles somewhat more acute.

Elytra parallel-sided; apex widely emarginate, more strongly mucronate on each side; punctures more regular, in definite striae; with three rows of tubercles, first row on third interstice composed of 7-9 tubercles, for the most part small, becoming larger posteriorly, the basal tubercle also slightly larger, the apical much larger and acutely conical; second row with 6-7 erect, conical tubercles, the basal slightly larger than the ones following it, the two last larger and acute, the apical reaching a lower level than that of first row; seventh interstice with a conical infra-humeral spine and one or two small granuliform tubercles.

Venter flat, rather sparsely clothed with brown, with a median white vitta on the basal segments. Legs simple.

♀. Thickly clothed with light brown pubescence, strongly maculate with white, appearing obscurely vittate from certain directions.

Head, rostrum and prothorax as in male.

Elytra broader, with tubercles much debased, the first row about 8 in number, hardly larger than granules, the last longer and conical; second row with about 9, mostly small granules, the basal tubercle larger, the last two larger and more conical, the apical one in line with those on seventh interstice; third row with a small but definite infra-humeral tubercle and 3-4 small granules.

Venter clothed with brown pubescence, with a median white vitta, and traces of lateral vittae.

Dimensions: ♂. 9.5 x 3 mm.; ♀. 11 x 4.5 mm.

Hab.—Western Australia: King George Sound.

This species is commented on under the preceding one—*H. furcatus* Macl.

HYBORRHYNCHUS BICORNUTUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1866, p. 333.

♂. Elongate, narrow; densely clothed with brown and grey subpubescence; sides with white clothing, irregularly arranged on prothorax, forming two incomplete vittae on elytra.

Head somewhat depressed in front; frontal tubercles absent; supraorbital tubercles large and conical. Rostrum widely excavate above, lateral margins raised into a strong triangular tubercle; basal tubercles small and granuliform, moderately close together. Antennae with second joint of funicle longer than first.

Prothorax produced over head above; submedian tubercles with the apical one moderately strong, projecting upwards and forwards, followed by a row of 3 or 4 obtusely conical erect tubercles in single series, diminishing in size towards base; lateral margins with a moderately strong tubercle in front of anterior constriction, the antero-lateral tubercle large and outwardly projecting, the postero-lateral smaller but acute.

Elytra elongate, narrow; base with forward projecting tubercles at the ends of the first and third interstices; apex emarginate, rather briefly mucronate on each side; punctures moderately regular and distinct; with two rows of tubercles, first row with about 10, the first moderately large and acute, followed by about 7 smaller, closely set, obtuse tubercles and then with three larger more conical tubercles, the last being strongly spiniform; second row with 6-7 erect spiniform tubercles, the first and the last two rather longer than the others, the apical descending to a lower level than the apical tubercle of first row; seventh interstice with a single infra-humeral spine.

Venter moderately densely clothed with brown, with traces of a white median vitta. Legs elongate, slender.

♀. Head, rostrum and prothorax similar to ♂. Elytra broader, more rounded; tubercles greatly debased, those on third interstice forming a slightly raised ridge, the component tubercles only traceable at the two ends, the apical tubercle moderately strong; fifth interstice with 7-8 tubercles, all distinct but much smaller than in ♂.; infra-humeral spine small and granuliform. Venter convex.

Dimensions: ♂. 9.5 x 3.5 mm.; ♀. 10 x 4 mm.

Hab.—South Australia: Port Lincoln.

H. bicornutus may be distinguished from its congeners by the almost complete absence of the basal rostral spines, which are represented merely by two granules. Described from specimens (? types) in Macleay Museum.

NEOHYBORRHYNCHUS, n.g.

Genotype—*Hyborrhynchus rugosus* Macl.

Elongate, narrow species, allied to *Hyborrhynchus*.

Head convex, front rugose, with supraorbital ridges, not tubercles. Rostrum separated from head above by a transverse impression; upper surface deeply excavate, the clypeal plate inserted between the ends of the external margins. Scrobes extending back to anterior margin of eyes. Eyes rotundate, moderately coarsely faceted. Prothorax longer than wide, convex, without lateral tubercles. Elytra elongate, strongly transversely convex; base contained between the pro-

jecting ends of the third interstices; with three isolated tubercles on each elytron, situated posteriorly.

Other characters as in *Hyborrhynchus.*

The species *H. rugosus* Macl., for which this genus is proposed differs so widely from the other species included in *Hyborrhynchus,* that I cannot regard it as congeneric with them. The absence of tubercles on head and rostrum, the position of the clypeal plate, the shape of the prothorax and the arrangement of the few isolated elytral tubercles all form points of distinction. At the same time it appears to be more nearly allied to *Hyborrhynchus* than to any other genus, and the rugosities of the head correspond in position to the tubercles of *Hyborrhynchus.*

Only the one species is so far known, and like most of the other species of the group, this is found in the south-western corner of the continent.

NEOHYBORRHYNCHUS RUGOSUS (Macl.)

Hyborrhynchus rugosus, Macleay, Trans. Ent. Soc. N.S. Wales, i., 1865, p. 298.

♂. Elongate, narrow. Black, densely clothed with brown depressed pubescence; with lighter setae on head and prothorax.

Head with upper surface convex and somewhat rugose, an oblique ridge on each side of median ridge convergent on base of rostrum; a raised ridge on each side above eyes. Rostrum separated from head above by a rather lightly impressed sinuate line; upper surface concave, the concavity narrowed behind by the approximation of the internal ridges, the latter long and prominent; lateral margins raised in a distinct, though not high, ridge, not tuberculate nor angulate, separated from the internal ridges posteriorly by an elongate basal fovea. Antennae elongate, slender; funicle with second joint longer than first; club moderately long, not pedunculate. Eyes briefly ovate.

Prothorax longer than broad, widest anteriorly and somewhat narrowed to base; apical margin slightly produced above and with feeble ocular lobes; disc with well-marked subapical constriction; median line impressed; set with rather irregular, obscure granules.

Elytra elongate, slightly widened posteriorly; base with rather strong forward projections at ends of first and third interstices, width across outermost equal to width of base of prothorax; disc with punctures narrow, transversely confluent, separated by transverse rugae, giving the derm a wrinkled appearance; third interstice raised and culminating in a large acute tubercle above declivity; fifth with two tubercles, smaller than the one on the first, and situated anterior and posterior to it.

Venter flat, with scattered light-coloured setae. Legs simple.

♀. Similar but larger and broader; elytral tubercles slightly smaller. Venter convex.

Dimensions: ♂. 12 x 4 mm.; ♀. 15 x 5.5 mm.

Hab.—Western Australia: King George Sound.

The elongate, strongly transversely convex form, and the three isolated tubercles above the declivity on each elytron render this species readily recognisable.

PARAHYBORRHYNCHUS, n. g.

Genotype—*Acantholophus convexiusculus* Macl.

Small, much broader across elytra than across prothorax.

Head separated from rostrum by a transverse sulcus; supraorbital crests present, single, erect. Rostrum deeply excavate above, lateral margins tuber-

culate; clypeal plate more or less sunken, not exserted; submentum with median forwardly projecting lobe. Scrobes short, straight, ending some distance in front of eyes. Eyes rotundate, rather coarsely faceted. Prothorax shaped much as in *Hyborrhynchus;* anterior margin produced slightly, without ocular lobes; disc with a row of tubercles on each side of median area; lateral margins tuberculate. Elytra very broad; suddenly narrowed to base, which is contained between the projecting ends of the third interstices; apex rounded, not emarginate nor mucronate; disc striate-punctate; interstices granulate. Venter more or less flattened in ♂, convex in ♀. Legs moderately long; tarsal joints short.

The present genus is proposed for the reception of two species—*Acantholophus convexiusculus* Macl. and *Hyborrhynchus crassiusculus* Macl.

The position of the former of these has been a good deal questioned. Macleay described the species as an *Acantholophus,* but subsequently in describing *mastersi,* which is certainly not specifically distinct, he placed it under *Hyborrhynchus.* Lea (Trans. Roy. Soc. S. Aust., 1903, p. 112) in recording the above synonymy, states that the species belongs to the same genus as *Cubicorrhynchus spinicollis* Macl. With this I do not agree, and in revising the genus *Acantholophus* I tentatively referred *A. convexiusculus* to *Hyborrhynchus.* It seems better now to form a new genus for it and for *H. crassiusculus* which is congeneric.

Parahyborrhynchus differs from *Hyborrhynchus* in its shorter broader form, in the more deeply set clypeal plate, and in the short scrobes. The shape of the rostrum is also somewhat different but the difference is scarcely definable. The two species may be separated thus:

Supraorbital crests large and conspicuous .. .. *P. convexiusculus* Macl.
Supraorbital crests granuliform; with a pair of frontal granules, not quite in the same line .. .. *P. crassiusculus* Macl.

PARAHYBORRHYNCHUS CONVEXIUSCULUS (Macl.)

Acantholophus convexiusculus Macl., Trans. Ent. Soc. N.S. Wales, i., 1866, p. 330; Lea, Trans. Roy. Soc. S. Aust., 1903, p. 112.

♂. Small, narrow across prothorax, broad across elytra, strongly convex. Black; rather densely clothed with brown depressed pubescence, with traces of greyish vitta on elytra.

Head somewhat rugulose above, with a short noduliform ridge somewhat obliquely set on each side of middle, with indications of an almost obsolete median ridge; supraorbital crests large, trianguliform, rather obtuse, projecting forwards and upwards and slightly outwards. Rostrum short and wide, rather deeply excavate above, external margins strongly raised in a large obtuse tubercle, sinking to base and apex; internal ridges low, convergent to base. Antennae slender; funicle with second joint longer than first, other joints short; club short, not pedunculate. Eyes small, rotundate.

Prothorax broader than long, the anterior margin slightly produced above; median area moderately deeply depressed; submedian tubercles 4 in number on each side, small, erect, obtuse; lateral margins with a single, large, outwardly projecting tubercle, slightly in front of middle, and with a small granule near posterior angle.

Elytra much wider than prothorax, broadly ovate, strongly declivous posteriorly; base with strong forward projecting tubercles at ends of first and third interstices; width across the outer of these equal to width of base of prothorax; disc with rows of fairly definite punctures; the interstices granulate, the granules more marked on the posterior portions of the third and fifth interstices, which appear feebly raised; fifth and seventh interstices with small nodules at base.

Venter feebly transversely convex, with scattered dark setae, and faint traces of median and lateral vittae.

♀. Very similar, somewhat more convex and obese; venter more strongly convex.

Dimensions: ♂. 9 x 4 mm.; ♀. 10 x 5 mm.

Hab.—N.S. Wales: Shelley's Flat (Goulburn), Sydney, Portland, Capertee; Victoria: Wandong, Mt. Evelyn; S. Australia; W. Australia.

The above description is taken from the types in the Macleay Museum. The species varies somewhat in the rugosities of the head and in the development of the elytral granules.

P. CONVEXIUSCULUS var. MASTERSI Macl.

Hyborrhynchus mastersi, Macl., Trans. Ent. Soc. N.S. Wales, i., 1866, p. 334.

Very close to *P. convexiusculus*.

Head with submedian ridges shorter and mere nodules; supraorbital crests slightly smaller, the space between less depressed. Rostrum similar. Antennae with all the joints of the funicle longer and more slender, the club much longer, with an elongate peduncle. Prothorax with median area deeply grooved in centre; submedian tubercles rather smaller. Otherwise as in *convexiusculus*.

Dimensions: ♂. 9 x 4 mm.; ♀. 10 x 4.5 mm.

Hab.—South Australia, Port Lincoln.

The above description is taken from the specimens in the Macleay Museum. The differences noted when compared with the types of *P. convexiusculus* become of less importance when a series from various localities is examined. Even the differences in the length of the joints of the funicle do not appear to be constant in South Australian specimens, and it might be better to follow Lea in sinking *mastersi* as an absolute synonym of *convexiusculus*.

PARAHYBORRHYNCHUS CRASSIUSCULUS Macl.

Macleay, Trans. Ent. Soc. N.S. Wales, i., 1866, p. 334.

♂. Allied to *P. convexiusculus* Macl.; comparatively broad, elytra parallel-sided. Black; densely clothed with brown and golden brown pubescence, variegated with grey on elytra; setae long, dark.

Head convex, with small, granuliform frontal and supraorbital tubercles, about equal in size, the frontals slightly posterior to the supraorbitals. Rostrum wide, upper surface deeply and widely excavate, the lateral margins raised in middle into a strong rectangular tubercle; with two small, granuliform, basal tubercles, rather widely separated. Antennae slender; funicle with first two joints subequal; club with elongate base. Eyes subrotundate, coarsely faceted.

Prothorax with apical margin slightly produced above, without ocular lobes; disc broad, explanate, with median line impressed in anterior half, obscurely carinate posteriorly, with small somewhat sparsely set granules; submedian tubercles small, obtuse, irregularly arranged; lateral margins bituberculate, the anterior tubercle large and triangular, outwardly projecting, the posterior smaller, less acute.

Elytra comparatively broad, sides parallel for the greater portion of their extent; apex rounded, not emarginate nor mucronate; base with forwardly projecting processes at ends of the first three interstices; disc with moderately well defined rows of punctures, often laterally confluent; third interstice outwardly turned at base to join humeral angle; all the interstices with small, closely set, setigerous granules, more conspicuous on third, fifth and seventh

and becoming larger posteriorly; infra-humeral tubercle on seventh very slightly longer than the granules on basal portion of interstice.

Venter feebly depressed at base with intermediate segments comparatively short; the apical segment rather coarsely punctured, the whole with pale decumbent setae. Legs simple.

♀. Similar, elytra wider, more rounded, with apex more produced; granules smaller, less distinct. Venter strongly convex.

Dimensions: ♂. 11 x 4 mm.; ♀. 12 x 5 mm.

Hab.—Western Australia: King George Sound.

Closely allied to *P. convexiusculus* Macl., the present species may be distinguished by the smaller supraorbital crests, which are hardly more than granules, and are set slightly anterior to the frontal granules so that the head presents a transverse row of 4 granules across the front. The postero-lateral tubercle of the prothorax is also definitely developed.

The median lobe of the submentum is in this species very broad and but little advanced, so that from some positions the emargination appears straight.

The above description was taken from the types in the Australian Museum.

ANASCOPTES.

Pascoe, Journ. Linn. Soc., xii., 1873, p. 7.

Genotype—*A. muricatus* Pasc.

Head concave in front; not distinctly separated from upper surface of rostrum; supraorbital tubercles present. Rostrum with upper surface hardly excavate, somewhat concave at base; lateral margins feebly angulate, hardly definitely tuberculate anteriorly; basal tubercles present; clypeal plate exserted. Scrobes short, commencing hardly farther forward than the middle of the rostrum and extending to the inferior border of the eye. Antennae with scape moderately long. Eyes round, prominent, coarsely faceted. Prothorax angulate or tuberculate on each side; anterior margin produced above, without ocular lobes; disc with submedian tubercles separating median and sublateral areas. Elytra oval; base contained between the projecting ends of the third interstices. Ventral surface flattened. Legs simple; tarsi short.

The type species was examined at the British Museum, and a detailed description made. I now add two new species to the genus, one of which has sometimes been identified as Pascoe's species. All three species are from Western Australia.

In his table of the long-scaped *Amycterinae* (*loc. cit.*, p. 21) Pascoe placed *Anascoptes* with *Polycreta,* distinguishing both from *Hyborrhynchus* by the narrow rostrum.

I do not think however that *Polycreta* is really related to *Anascoptes.* The genus is hardly separable from *Ennothus* which was placed by Pascoe among the short-scaped *Amycterinae* (Euomides), and both genera seem more closely allied to *Oditesus.*

Further consideration of *Polycreta* is therefore deferred for the present.

Anascoptes appears to me more nearly allied to *Hyborrhynchus* than to the *Euomides,* the relation of the base of the elytra to the prothorax being the same in the two genera.

Anascoptes is however separated from the other three genera of the group by the upper surface of the rostrum not being deeply excavate, though it may be shallowly concave, particularly between the basal tubercles. In the type species (*A. muricatus* Pasc.) these basal tubercles are widely separated and

apparently situated on the external margins; in the two new species herein described these tubercles are approximated and internal to the margins. It might be questioned whether this difference should not be regarded as of generic importance, but one of the two new species is otherwise very similar to the type species though the other differs rather widely in general appearance.

The three species may be distinguished by the following table:

1 (4) Strongly tuberculate species.
2 (3) Basal rostral tubercles widely separated ... ... *A. muricatus* Pasc.
3 (2) Basal tubercles approximated ... ... *A. fasciatus*, n.sp.
4 (1) With obliterate sculpture, the tubercles obsolescent ... *A. obliteratus*, n.sp.

ANASCOPTES MURICATUS Pasc.

Pascoe, Journ. Linn. Soc., xii., 1873, p. 7, Pl. ii., f. 6.

Elongate, comparatively broad across elytra, small. Black; with dingy brown clothing.

Head concave in front, not separated from rostrum by a sulcus; with an erect spine on each side above eye. Rostrum comparatively short and broad, with an erect spine or crest on each side of base at lateral margin, slightly outwardly projecting; dorsal surface concave between crests, then sloping downwards and forwards to apex; scrobes short ending opposite anterior margin of rostral crests. Antennae with scape moderately long, fairly stout. Eyes prominent, coarsely faceted.

Prothorax comparatively narrow, the width across base hardly equal to width of elytra across the third interstices; lateral margins strongly angulate in front of middle, then sloping to base and apex; apical margin rather strongly produced above, ocular lobes absent; median line depressed throughout, bordered on either side by erect, conjoined tubercles, these forming short parallel crests in anterior portion, and basally convergent crests from middle to base; rest of surface non-tuberculate.

Elytra very broad, subparallel on sides; base formed by the portion between the projecting ends of the third interstices; first interstice with a raised crest on each side of scutellar region, divergent, forwardly projecting; third and fifth interstices curved with convexity inwards, each with a row of rounded tubercles, becoming larger posteriorly and basally, not reaching base and not extending down declivity; seventh interstice with an infra-humeral tubercle, followed by a row of small tubercles, all contained within the curve of the fifth interstice. Under-surface flattened. Tarsi short.

Dimensions: Long. 3 lin. (Pascoe).

Hab.—Western Australia: Albany.

The above description was drawn up from the type specimen in the British Museum; no measurements were however made, so the length given by Pascoe is quoted.

No notes were made on the relation of the posterior end of the scrobe to the eye; Pascoe describes the scrobe as running below the eye, reference to his figure shows that the position is not essentially different from that described for the following species, the interpretation of anterior and lower depending on the position of the head. In the generic diagnosis Pascoe describes the rostrum as trituberculate; this is hardly correct, the three tubercles are shown in the figure but the basal one really represents the supraorbital crest, while the anterior is hardly more than a slight angulation.

Since the above notes were written I have had an opportunity of examining a specimen of this species from Mr. A. M. Lea's collection. The scrobe is strongly curved downwards in front of the eye; as the head is bent downwards the relative position of the scrobe is below the eye, thus corresponding with Pascoe's figure. The species can be readily separated from the following by the position of the basal tubercles of the rostrum and by the more acute tubercles both on prothorax and elytra. The size is smaller (5.5 x 2 mm.). The position of the head renders a view of the submentum difficult, the median lobe can however be seen from certain directions, though it appears to be shorter than in the other two species.

ANASCOPTES FASCIATUS, n. sp.

♂. Small, elongate. Black; rather sparsely clothed with fine greyish sub-pubescence, a denser fascia across base and one above declivity.

Head not definitely separated from rostrum above; with a strong, erect, rather obtuse tubercle above each eye. Rostrum short, broad, not excavate, external margins not raised, divergent basally, with a small prominence, hardly a definite tubercle, over insertion of antennae; with two strong tubercles at extreme base, anterior and internal to the supraorbital tubercles, and separated by a fairly deep sulcus. Scrobes strongly curved, extending to lower margin of eyes. Antennae with rather short, moderately incrassate scape; funicle with second joint distinctly longer than first. Eyes rotundate, rather coarsely faceted.

Prothorax pentagonal in shape, the apex rather strongly produced over the head, without ocular lobes; median area depressed, with a deeper line in centre, bordered on either side by a series of tubercles, conjoined into a distinct ridge, the anterior tubercle projecting over the head, the middle tubercle the largest and situated more outwardly; lateral margins with a strong outwardly projecting tubercle anterior to middle, followed by a definite ridge, slightly inwardly directed, to base; sides with three vertical impressions above, non-granulate.

Elytra considerably wider than prothorax, the width across the third interstices at base equal to width of base of prothorax; sides subparallel in median portion, obliquely truncate at base; base with strong forwardly projecting tubercles at ends of first and third interstices; disc with rather large punctures, separated by non-granulate ridges; first interstice non-granulate, with a single basal tubercle; third interstice curved outward at base and towards apex, with a double humeral tubercle, projecting forwards, followed by a row of about 6 tubercles, small granuliform towards base, becoming larger towards apex, the last large and conical, situated at top of declivity; fifth interstice outwardly curved towards base and apex, with a forward projecting tubercle anteriorly, but posterior to basal tubercle of the third interstice, followed by about 6 tubercles, the basal ones small, the apical larger and more conical, the penultimate the largest, but smaller than apical tubercle of third interstice, the last situated about half-way down declivity; seventh interstice with a single infra-humeral tubercle. Sides non-granulate.

Venter rather closely pubescent, without median vitta, flattened; intermediate segments short; apical segment with a rather shallow apical transverse depression.

Tarsi short, rather strongly setose; under surface of joints rather densely pubescent.

Dimensions: ♂. 7 x 3 mm.

Hab.—Western Australia: Mt. Barker (A. M. Lea).

In general appearance resembling *A. muricatus*, the present species can be

at once distinguished by the position of the basal rostral tubercles—closely approximated in *A. fasciatus*, widely separated in *A. muricatus*.

The median lobe of the submentum is a strong tongue-like process projecting far into the oral aperture.

(Holotype ♂ in author's collection).

ANASCOPTES OBLITERATUS, n. sp.

Small, broad; in general appearance resembling *P. convexiusculus* Macl. Black; densely clothed with fine dingy subpubescence.

Head convex, front somewhat flattened; with moderately large obtuse noduliform supraorbital crests. Rostrum not distinctly separated from the head; upper surface not excavate, clypeal plate exserted; lateral margins very feebly obtusely angulate about middle of rostrum, becoming indistinct towards apex and divergent towards base, where the margins run into the base of the supraorbital tubercles; upper surface with a pair of moderately large separate tubercles at junction with head. Scrobes not reaching farther forwards than middle of rostrum, and posteriorly curved down in front of eyes. Antennae with scape rather strongly incrassate at apex; funicular joints short, first and second subequal; club short, stout. Eyes small, round, rather coarsely faceted.

Prothorax slightly produced above, without ocular lobes; upper surface somewhat flattened; median area rather shallowly depressed; submedian tubercles obsolescent, practically fused to form a somewhat rugose, feebly raised ridges, broad in the middle, narrow at each end, especially the anterior; lateral margins dentate, hardly explanate, with a short obtuse tubercle slightly anterior to middle.

Elytra short and broad; base contained between the ends of the third interstices, with short forward projections at the ends of the first and third interstices; sculpture much obliterated, the punctures barely traceable; the third, fifth and seventh interstices feebly elevated, without definite granules or tubercles except for one or two obsolete nodules on the third and fifth near declivity, and an obtuse infra-humeral nodule on the seventh. Venter flat, feebly depressed at base; with rather large, round, scattered punctures. Legs comparatively short, posterior tarsi short.

Dimensions: ♂. 6.5 x 3 mm.

Hab.—Western Australia (H. J. Carter).

I place this species in *Anascoptes* with a great deal of hesitation. It has the general appearance of *P. convexiusculus* Macl., and a rostral sculpture similar to that of *A. fasciatus*. Possibly a new genus should have been erected to receive it, but I am unwilling to do this until more specimens are available.

Holotype ♂ in author's collection.

SPECIAL GENERAL MEETING.

28TH SEPTEMBER, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Business: To consider the confirmation of the alterations to the Rules approved at the Special General Meeting on 31st August, 1921.

On the motion of Mr. J. H. Campbell, seconded by Mr. W. Welch, it was resolved that the resolution agreed to at the Special General Meeting on 31st August, adopting the draft Rules submitted to replace the existing Rules, be now confirmed.

ORDINARY MONTHLY MEETING.

28TH SEPTEMBER, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Miss Grace Anderson, B.Sc., Park Avenue, Gordon, was elected an Ordinary Member of the Society.

The President announced that the Council had elected Dr. E. W. Ferguson to be a member of the Council in place of Mr. J. E. Carne, resigned.

The Donations and Exchanges received since the previous Monthly Meeting (31st August, 1921), amounting to 82 Vols., 92 Parts or Nos., 2 Bulletins, 1 Report and 41 Pamphlets, received from 36 Societies and Institutions and two private donors, were laid upon the table.

NOTES AND EXHIBITS.

Acting-Professor L. Harrison exhibited, on behalf of Mr. Harry Burrell, two living young of the platypus, *Ornithorhynchus anatinus* Shaw, which arrived in Sydney on the morning of the meeting, having been sent by Mr. Burrell from the Namoi River. The young were accompanied by two living adult females. The former are estimated to be about five weeks old.

It was resolved to send a letter to Mr. Burrell congratulating him on the results of his collecting.

Mr. W. W. Froggatt exhibited a new aphid that has infested the native cypress over an area of about 100 miles from Dubbo to Condobolin, and appears to have killed many large trees. They were first reported about two months ago and simply smothered the branchlets and main branches of the trees. Since then they have been cleared from many of the large trees by the red and black spotted ladybird beetle (*Leis conformis*) which has appeared in very large numbers. If the latter continue to increase they will probably save all the smaller trees on to which the aphis are now crawling from the larger trees that were the first to be attacked.

Mr. A. N. Burns exhibited specimens of *Argynnina hobartia cyrila* from Narrabeen and Ferntree Gully, Victoria. The specimens from Narrabeen are much larger and rather darker than the Victorian examples. It is remarkable that this species should occur so near the coast at sea level, being an inland mountain species in Victoria. It appeared to be more abundant at Narrabeen than in its Victorian haunts.

Mr. W. F. Blakely exhibited from the National Herbarium the following species of *Pterostylis* with the labellum emarginate or bifid which is contrary to the normal form. (1). *P. obtusa* R. Br., Hobson's Bay, Victoria (C. Walter, July-Aug., 1896). The cleft labellum somewhat resembles *P. concinna* R. Br., but it is more contracted towards the top, with a broad band commencing at the junction of the lobes and gradually diminishing downwards; lobes ¾ mm. long. (2). *P. nutans* R. Br., Batlow (R. B. Timmis, Nov., 1910); Mt. Lofty Ranges (*ex* Herbario C. E. Menzel, Sept., 1897). The labellum is somewhat similar to that of *P. obtusa* but the lobes are barely ½ mm. long. These two forms approach *P. nutans* R. Br., var. *hispidula* Fitz. (3). *P. reflexa* R. Br., Mittagong (W. Greenwood, No. 706, Feb., 1916). Labellum linear, abruptly expanded at the top into two obtuse lobes about 1.5 mm. long, the two lobes spreading to a little over 3 mm., while the labellum just below them is scarcely 1 mm. broad.

A NEW GENUS AND SPECIES OF MAY-FLY (ORDER PLECTOPTERA) FROM TASMANIA, BELONGING TO THE FAMILY *SIPHLURIDAE*.

By R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), C.M.Z.S., F.L.S., F.E.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

(Plate xxxiv., and two Text-figures).

The *Siphluridae* are probably the most archaic family of May-flies at present existing. Though found in many parts of the world, their head-quarters may justly be said to be in New Zealand, where the large and magnificent species of the genera *Oniscigaster, Coloburiscus* and *Ameletus* were abundant everywhere until the introduction of the Brown and Rainbow Trout greatly reduced their numbers. In Australia, the only record for the family so far is a single species of *Coloburiscus* from Victoria. Larvae closely resembling those of *Ameletus* are well known to me in some of the Blue Mountain streams, but they die almost as soon as taken out of the water, and I have never yet either seen or reared the imago. *Oniscigaster,* which is the most remarkable and probably the most archaic genus of the family, has so far not been recorded outside of New Zealand.

In January, 1917, I was on a visit to Cradle Mountain, Tasmania, with Mr. G. H. Hardy, then Curator of the Tasmanian Museum, Hobart. We left for Launceston on the 22nd. On the 21st, we paid our last visit to Lakes Dove and Lilla. While skirting the edge of the latter lake, on the return journey, I noticed a May-fly climbing up some reeds growing out of fairly shallow water in a small bay of the lake. I secured this in a pill-box, and at once saw that it was something of interest. In the course of a few minutes, five more subimagines of the same species emerged from the water and climbed up the reeds. All these were secured. Two of them were killed and set the same day. The other four were taken alive in the pill-boxes to Launceston, where we arrived on the 24th. Two of them died *en route,* but the other two changed into the imaginal stage late on the 23rd. Thus they existed more than two whole days, under adverse conditions, in the subimaginal stage. This long existence in the usually exceedingly short and transient subimaginal stage is also characteristic of the New Zealand *Siphluridae,* and is doubtless a survival of a very ancient habit of life, as is also the manner of emergence by crawling up a reed-stem, instead of by flying directly up from the surface of the water.

When examined, these May-flies proved to belong to the family *Siphluridae,* and also to be very closely allied to *Oniscigaster.* For their reception I here propose to define a new genus with the name *Tasmanophlebia,* as follows:—

Family SIPHLURIDAE.

Genus TASMANOPHLEBIA, n.g. (Plate xxxiv., and Text-figs. 1, 2.)

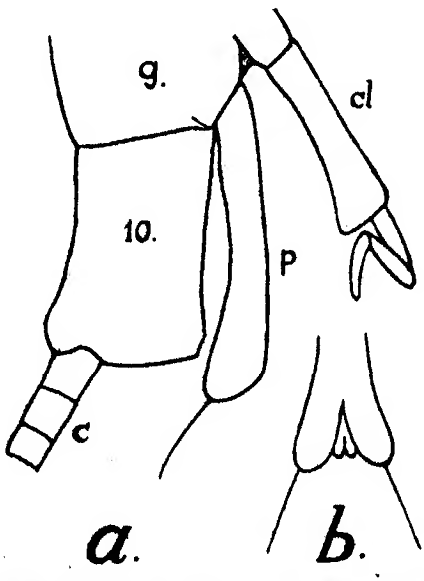
Insects having an expanse of about one inch, the hindwing about half as long and two-thirds as wide as the fore. Venation closely resembling that of *Oniscigaster*. Forelegs in male about three-fourths the length of forewing, those of female much shorter. Tarsus of hindleg longer than tibia. Tarsal claws dissimilar, one blunt and one sharply hooked. Abdomen narrowly cylindrical, without lateral dilatations on any of the segments. Cerci present, longer than abdomen, but the appendix dorsalis completely absent in both sexes.

Genotype, *Tasmanophlebia lacustris*, n. sp.

This genus is very close to the New Zealand genus *Oniscigaster*, from which it is to be distinguished by its much smaller size, its narrow cylindrical abdomen without any lateral dilatations, the complete absence of the appendix dorsalis in both sexes, and also by the habit of the larva dwelling in the still water of lakes. The larvae of all the other *Siphluridae* known in New Zealand and Australia dwell in the fast running water of mountain streams.

TASMANOPHLEBIA LACUSTRIS, n. sp. (Plate xxxiv., and Text-figs. 1, 2.)

♂, *Imago*: Total length, 14; forewing, 12; hindwing, 5.7; expanse of wings, 26 mm.



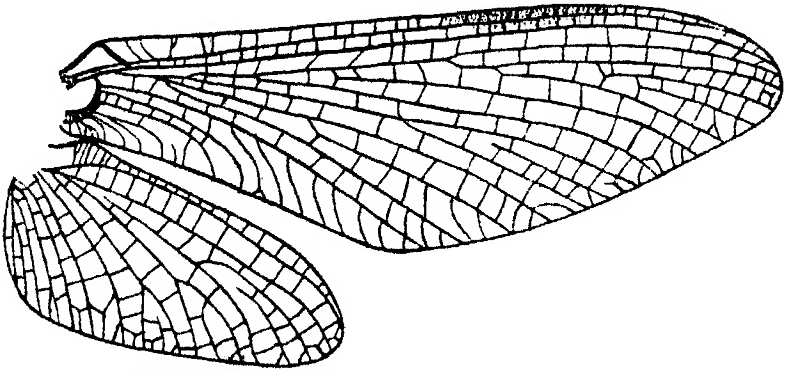
Text-fig. 1. *Tasmanophlebia lacustris*, n.g. et sp., genitalia of male imago. *a*, lateral view of end of abdomen, showing base of cercus *(c)*, left clasper *(cl)*, and penis *(p)*. Right clasper omitted. 9, 10, the last two segments of the abdomen. (x 40). *b*, Ventral view of distal portion of penis. (x 40).

Head and *thorax* rich dark brown. *Forelegs* 9 mm. long, dark brown; *middle-* and *hindlegs* medium brown.

Abdomen dark shining brown, the segments separated very distinctly by

pale annuli. *Cerci* 13.5 mm. long, medium brown, with from 45 to 50 segments.* *Genitalia* as shown in Text-fig. 1.

Wings shining hyaline, suffused with rich umber brown basally and along costa to beyond pterostigma, as shown in Plate xxxiv., fig. 1. This colour is darkest on the pterostigma of forewing, fairly dark on the anal area of the



Text-fig. 2. *Tasmanophlebia lacustris*, n.g. et sp., wing-venation of ♀ imago. (x 7¼).

same wing and on costa of hindwing, and paler on the rest of the suffused area. Veins dark brown. *Venation* as shown in Text-fig. 2.

♀, *Imago*: Total length, 13; forewing, 11.5; hindwing, 5.8; expanse of wings, 25 mm.

Similar to male, except that the forelegs are only 5 mm. long, the eyes smaller, the abdomen rather duller, with less conspicuous annuli separating the segments, and the wings somewhat narrower and almost totally hyaline, being only suffused with brown on the pterostigma and at their bases, as shown in Plate xxxiv., fig. 2.

♂, *Subimago*: Differs from the imago in being a somewhat smaller and slenderer insect, the body colouring duller, the forelegs and cerci much shorter, the wings narrower, not hyaline, but clouded with pale dull greyish; pterostigma and all the veins dark greyish; a touch of brown at bases of wings. (Plate xxxiv., fig. 3.).

♀, *Subimago*: Closely resembling the male subimago, but having the abdomen a duller greyish brown, and the brown at the base of the wings more conspicuously present. (Plate xxxiv., fig. 4).

Hab.—Lake Lilla, 3200 feet, near Cradle Mountain, N.W. Tasmania.

Types. Holotype ♂ imago and allotype ♀ imago, reared from subimagines, Jan. 23rd, 1917. Also ♂ and ♀ subimagines, taken Jan. 21st, 1917, at same time as imaginal types. All these in the Tillyard Collection, Cawthron Institute, Nelson, N.Z.

The discovery of this insect throws some interesting light upon the close relationships existing between the Australian and New Zealand May-fly Fauna. New Zealand, with its abundant, rapid and ever-flowing rivers, and its numerous lakes, is a paradise for these insects. Australia, on the other hand, with its

* The cerci of the type male imago were accidently broken off before the photographs were taken for Plate xxxiv.

dry climate, its sparse river-systems, many of which cease to flow during droughts, and its absence of lakes, is about as unfavourable a region for their development as can be found anywhere. Now in New Zealand the dominant family everywhere is the *Leptophlebiidae,* represented by the two genera *Atalophlebia* and *Deleatidium.* The same family is dominant in Australia, the genus *Atalophlebia* containing most of the known Australian species of Mayflies. The only other two families known in New Zealand are the *Siphluridae* and the *Ephemeridae,* the former being represented by the three genera already mentioned at the beginning of this paper, the latter by the single fine genus *Ichthybotus,* peculiar to New Zealand. Of the three New Zealand genera of *Siphluridae, Coloburiscus* is represented in Australia by a single Victorian species, *Ameletus* occurs on the Blue Mountains, though the species has not yet been described, and now we see that the most remarkable genus of all, *Oniscigaster,* is found to have its counterpart in the closely allied Tasmanian genus described in this paper. As regards the genus *Ichthybotus,* I have myself collected larvae belonging to this genus in the Fish River, N.S.W.; and there is, in the National Museum at Melbourne, a fine subimago of another species, not yet described, from the Upper Yarra River.

The only element of the Australian Mayfly fauna not present in New Zealand, or at any rate not yet discovered there, consists of two exceedingly small tropical species of the family *Baetidae,* one of which extends as far south as New South Wales, while the other is confined to the Northern Territory. It is possible that a representative of this family may yet be found in the North Auckland district in New Zealand.

Thus we see that the Mayfly faunas of Australia and New Zealand are very closely allied, in spite of the difference of climate. The same is true of the Stonefly fauna, though that of Australia is only just beginning to be made known.

In concluding this paper, I wish to thank Mr. W. C. Davies, Curator of the Cawthron Institute, for taking the excellent photograph from which Plate xxxiv. has been prepared.

EXPLANATION OF PLATE XXXIV

(All figures x 2½).

Fig. 1. *Tasmanophlebia lacustris,* n.g. et sp., male imago.
Fig. 2. ,, ,, ,, ,, female imago.
Fig. 3. ,, ,, ,, ,, male subimago.
Fig. 4. ,, ,, ,, ,, female subimago.

TWO FOSSIL INSECT WINGS IN THE COLLECTION OF MR. JOHN MITCHELL, FROM THE UPPER PERMIAN OF NEWCASTLE, N.S.W., BELONGING TO THE ORDER HEMIPTERA.

By R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), C.M.Z.S., F.L.S., F.E.S., Entomologist and Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

(Plate xxxv., and five Text-figures).

The two fossil insect wings dealt with in this paper were discovered by Mr. John Mitchell under somewhat remarkable circumstances, which are best explained by quoting his own words to me in a letter:—

"These two wings were obtained from debris of the embankments of the Burwood Colliery railway, made up of the material taken from two tunnels which had to be made in the course of its construction. The floors of these tunnels are only three or four feet above the Dirty Seam of the Newcastle Series of Coal seams, and are practically identical with the geological horizon from which *Permoscarta mitchelli* Till. was collected. But the embankments are close to the sea, and frequently, during heavy storms, suffer much damage from the waves beating upon them. This periodical damage has been mostly repaired with chitter (impure coal and bands of mudstone, etc.) and other refuse from the Burwood Colliery. Thus it is possible that these two wings (or one or other of them) came from the Burwood Coal Seam horizon, which is from one hundred to one hundred and twenty feet above the Dirty Coal Seam; but it is much more likely that they came from the lower horizon before mentioned.

"The bricky or burnt condition of the material in which the wings occur was produced by the spontaneous combustion of the material of which the embankments have been composed. This kind of combustion always happens in heaps of coal or of chitter after exposure for a lengthened period of time to atmospheric influences.

"It is unfortunate that these wings were not found *in situ;* for, if they had been, we would know exactly where to look for others belonging to the same geological horizon, a matter of great scientific importance considering the uniqueness of each of these wings."

The material in which the fossils occur is of a bright brick-red colour and very hard, reminding one of the bricks made by the Romans and used by them in ancient Roman buildings in England. The material has a shallow conchoidal fracture, for the most part very smooth. The wings are associated with plentiful remains of small fronds of a species of *Glossopteris*. The smaller wing, in fact,

is preserved right in the middle of one such frond, as may be seen from Plate xxxv., fig. 2. Owing to the material having been burnt, the impressions, both of the wings themselves and of the *Glossopteris* fronds, are very hard and very clearly marked. The embankment from which they were taken is at Merewether Beach, about four miles south of Newcastle, N.S.W.

These two wings were lent to me by Mr. Mitchell and have been in my possession for about two years, during which time I have studied them frequently, but found it difficult to determine with certainty their systematic positions. I should doubt if two more unique types of insect wing have ever before been found. Moreover, the very simplicity of their venation adds to the difficulty of placing them. On the one hand, they stand far apart from all known Carboniferous forms; while, on the other, they show no close affinities with any known Mesozoic, Tertiary or Recent forms. I have finally decided to place both wings within the Order Hemiptera, of which early representative types have already been discovered in the Upper Permian of Newcastle and Belmont in the shape of the two genera *Permofulgor* and *Permoscarta*. If my placing of these two fossils is correct, then it still remains true that, of all the wings so far discovered in these beds, there is not a single type that does not belong either to the Hemiptera or to the Mecoptera.

While further discoveries in these beds should most certainly increase the number of Orders represented in Australia at that period, one cannot but admit that it already appears evident that the dominant Insect Fauna of the Period was a mixed one of Plant Hoppers and Scorpion-flies. Such a combination can only be found in Australia, at the present day, in the damp bottoms of shady gullies, or along the shady southern slopes of steep hillsides, where dews fall heavily and remain long undispersed by the sun's rays. In such localities, Cockroaches should most certainly occur, if they had reached Australia at the time these insects were fossilized; so also should Megaloptera, and perhaps some early forms of Planipennia. Coleoptera, if evolved by then, would most certainly have been present also; the absence of this Order from the Upper Permian of New South Wales is one of the most striking facts about this horizon, considering how abundant they are, and how highly evolved, in the Upper Trias of Ipswich, Q.

Before going on to describe the fossils themselves, I wish to thank Mr. Mitchell for the opportunities he has given me for studying these and other fine insect fossils in his collection, and also to draw attention to the magnificent work which he has accomplished, and is still accomplishing, in spite of his advanced years, in the difficult and painstaking exploration of the Belmont and Newcastle Beds,—in which, as I know from personal experience, one has often to work for days on end without getting a single wing as a reward. I have also to thank Mr. W. C. Davies, Curator of the Cawthron Institute, for the two excellent photographic enlargements of the fossil wings, which are reproduced in Plate xxxv., figs. 1 and 2.

Order **HEMIPTERA**.

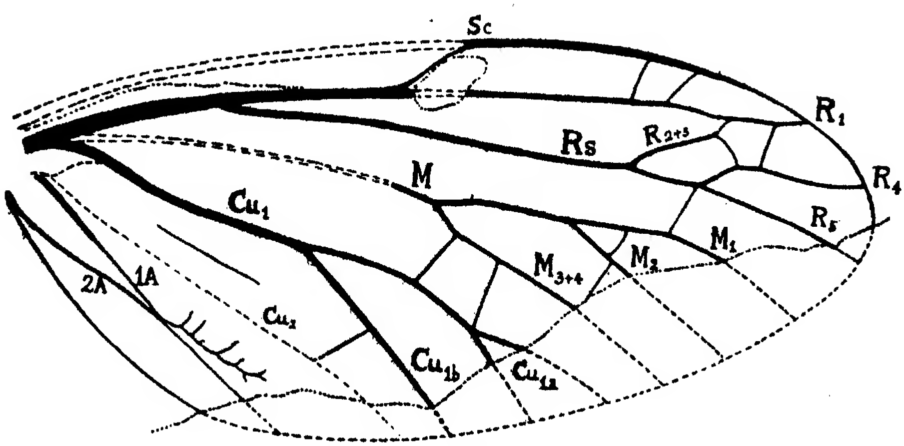
Suborder **Palaeohemiptera**.

Family PROSBOLIDAE.

Genus Mitchelloneura, n.g. (Plate xxxv., fig. 1; Text-fig. 1.)

Hindwing: Shape moderately broad and rounded at apex; veins very strongly built, but the wing membrane delicate. Sc short, fused with R_1, ending up at about half-way along the costal margin. R_1 very strongly formed, slightly

curved, ending up a little before apex. Rs arising at about one-fourth from base as a strongly built vein diverging gradually from R_1 and remaining unbranched until about one-fourth from apex; it then gives off an anterior branch, R_{2+3}, which runs obliquely upwards to join R_1, while the main portion R_{4+5}, runs straight on for a short distance and then forks into R_4 and R_5, which end up just above and below the apex respectively. M arises from R close to base and runs obliquely across the wing, sub-parallel to Rs; it remains simple to half-way, when it forks into M_{1+2} and M_{3+4}, the former again forking into M_1 and M_2, the latter remaining unforked. Cu_1 a very strong vein running obliquely and slightly divergingly below M to about one-third from base, where it forks into Cu_{1a} and Cu_{1b}, the former of which is again forked. Cu_2 only just indicated as a weak furrow vein. Anal area (possibly partly overfolded) with 1A and 2A present; 1A straight and simple, 2A waved.



Text-fig. 1. *Mitchelloneura permiana*, n.g. et sp. Hindwing. (x 6.7)
1A, 2A, anal veins; Cu_1, first cubitus, with its branches Cu_{1a} and Cu_{1b}; Cu_2, second cubitus; M, media, with its branches M_1, M_2 and M_{3+4}; Rf, main stem of radius; Rs, radial sector, with its branches R_{2+3}, R_4 and R_5; Sc, subcosta.

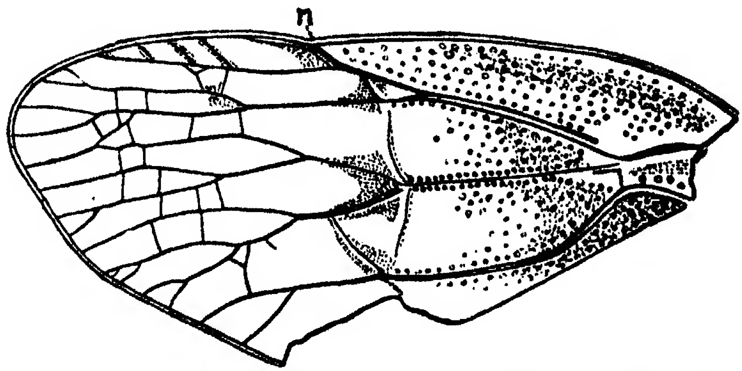
Genotype, *Mitchelloneura permiana*, n. sp.

Horizon, Upper Permian of Newcastle, N.S.W.

The generic name is given as a dedication to the discoverer of the Newcastle and Belmont fossil insects, Mr. John Mitchell.

Affinities: The short Sc, fused with R, the manner of branching of Rs and M, and especially the forked Cu_{1a}, indicate the Hemipterous nature of this remarkable fossil. The only known wing with which it seems to have any close affinity is that of *Prosbole hirsuta* Koken (Text-fig. 2) from the Upper Permian of the Kama River, Russia. This fossil is a forewing. The differences between it and *Mitchelloneura* are of the kind one would expect in comparing fore and hind wings of two fairly closely related insects. For example, *Prosbole* shows a definite beginning of the division of the wing into *corium* and *membrane*, as seen in most of the Heteroptera, and the corium is strongly tuberculated. In conjunction with this, it will be seen that a definite *node* is present just beyond

half-way along the costa, where Sc ends. It is certain that the hindwing of *Prosbole* had no division into corium and membrane, and also had no node, since neither of these specialisations has ever been developed in a hindwing of the



Text-fig. 2. *Prosbole hirsuta* Koken, hemelytron, after Handlirsch. (x 2.1). Upper Permian, Kama River, Russia. *n*, node.

Order. The general resemblance of the venational scheme in the two genera is evident enough, though the number of branchings of Rs and M is different. The general arrangement of the system of cross-veins is also similar, though *Prosbole* has more of them than *Mitchelloneura*. Characters shared in common by the two wings are:—the short Sc, fused with R, and ending up in a characteristic manner about half-way along the wing, the nearly straight R_1, with cross-veins connecting it with the costa, the general arrangement of Rs, M and Cu_1 with respect to one another, and their lack of branching or cross-veins before half-way along each of their lengths, the form of the fork of Rs, in which R_{2+3}, arches up anteriorly, while R_{4+5} runs almost straight on, the form of the fork of M_{1+2} and the forking of Cu_{1a}. On the other hand, R_{2+3} does not join up with R_1 in *Prosbole*; R_{4+5}, has an extra branch; M_2 is forked; and M_{3+4}, instead of being a simple vein, not only forks, but has an extra fork on M_4.

It seems reasonable to conclude that, if the forewing of *Mitchelloneura* were known, it would be sufficiently like that of *Prosbole* to allow the two genera to be placed within the same family, though not in the same genus.

MITCHELLONEURA PERMIANA, n. sp. (Plate xxxv., fig. 1; Text-fig. 1.)

H i n d w i n g: Total length, 17 mm; greatest breadth of specimen, 7 mm., representing a total width for the complete wing of about 7.5 mm.

The specimen is the mould or counterpart of a right wing, as is proved by the fact that R_1, Cu_1 and the anal veins are concave, while M is convex in the fossil impression. It rests in a slightly irregular hollow of a piece of hard burnt shale having a conchoidal fracture; the apex is to the left. Text-fig. 1 gives a diagram of the wing with the apex turned to the right, and the missing parts restored by the dotted lines. The softness and delicacy of the wing membrane is indicated by numerous signs of stretching and rucking present in the fossil. Except in some of the higher Holometabola, forewings having such a delicate structure of the membrane are seldom met with; and, as this is a wing of considerable size and very strong venation, this condition of the membrane

is strong evidence that we have to deal with a hind wing. The absence of a definite clavus points in the same direction.

Specific characters in the venation are the positions of the cross-veins: two, close together, connect R_1 with the costal margin; a curved cross-vein connects R_{2+3} with R_4, and, just beyond it, a straight one connects R_4 with R_1; another cross-vein descends from the fork of R_{4+5} on to M_1; a short curved cross-vein bridges the fork between M_1 and M_2, and, almost exactly below it, a straight cross-vein runs from M_2 to M_{3+4}. This latter vein is connected with Cu_{1a}, by two straight cross-veins, the more distal of which, placed slightly obliquely, falls directly on to the fork of Cu_{1a}; just before the middle of its length, Cu_{1b} sends a straight cross-vein to Cu_2.

The peculiar formation of vein 2A is very noticeable. Probably owing to an overfolding of the weak membrane, this vein appears to cross 1A at about the middle of its length, and then begins to give off a series of short, irregular stump-veins which quickly fade away into the membrane without joining up anywhere or reaching the wing margin. Possibly these are the last remnants of a weak archedictyon.

The missing parts of the wing are: the basal half of the costal margin, a small piece cut out of the middle of R_1, just distad from the free end of Sc, most of the basal half of M, almost the whole of Cu_2, and a narrow, irregular portion of the wing along the posterior margin, from just before the end of 1A right round to the apex.

Type in Mr. John Mitchell's Collection.

Locality.—Burnt shale from the embankment of the railway at Merewether Beach, near Newcastle, N.S.W.

Suborder **Homoptera.**

Division *STERNORRHYNCHA.*

Family LOPHIONEURIDAE, fam. nov.

A monotypic family, with characters as given for the genus *Lophioneura* below.

Genus LOPHIONEURA, n.g. (Plate xxxv., fig. 2; Text-fig. 3.)

Forewing: Size very small, shape elongate oval, about three times as long as broad. R and Cu_1 forming two high, sharp ridge-veins, strongly convex, and much stouter than the other veins, which are all flat and weakly formed. Sc short, ending on costal margin at about one-third from base. R arising from middle of base, and having the basal portions of M and Cu_1 fused with it; R_1 running nearly straight, obliquely upwards, to end on the costa about three-fifths from base; Sc and R_1 are roughly parallel. Rs a weak vein, arising from R at about one-sixth from base, and running in a gentle double-curve to beyond the level of the end of R_1, where it forks widely; the upper fork, R_{2+3}, runs parallel to R_1 to the costa; the lower fork, R_{4+5}, runs obliquely downwards to end up at apex. M arises from R a little before origin of Rs, and runs below it in a single concave curve nearly to the level of the end of R_1, when it forks similarly to Rs; the upper fork, M_{1+2}, arches upwards, and then curves to run below and parallel to R_{4+5} to a point well below apex; the lower fork, M_{3+4}, makes a very weak double-curve, and ends on the posterior margin a little beyond the level of the fork of Rs. Cu_1 arises from R a little before M, and runs as a high ridge to about half-way along the wing; this part of it makes a single continuous curve below and sub-parallel to M. At the point

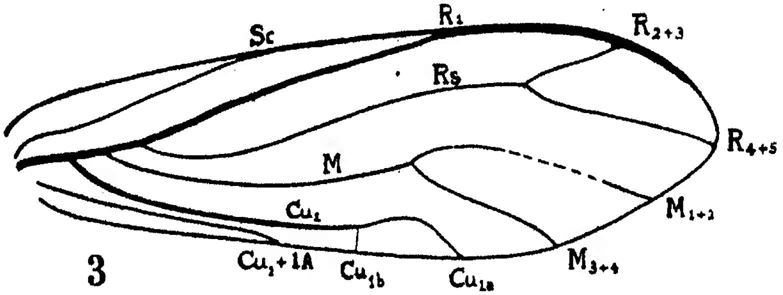
where the high ridge ceases, Cu_1 sends off a short branch, Cu_{1b}, directly to the wing-margin below it, while the main part, Cu_{1a}, becomes a weak vein, forming a well defined arch upwards beneath the fork of M, and then curving down to end up on the posterior margin at the same level as the end of R_1 on the costa. In the narrow space between Cu_1 and the posterior border, there lies a short, concave vein arising basally below R; this is probably $Cu_2 + 1A$, fused together. There are no claval veins present, the true clavus being reduced to the very narrow strip lying between this last vein and the posterior border.

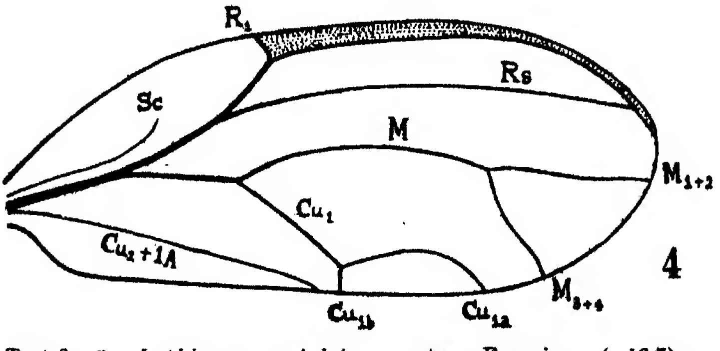
The membrane of the wing is evidently very tough, its impression completely obliterating that of the frond beneath it; there is an appearance of a very fine granulation all over it. (Plate xxxv., fig. 2).

Genotype. *Lophioneura ustulata*, n.sp.

Horizon, Upper Permian of Newcastle, N.S.W.

The generic name was suggested by the strongly formed ridges of the veins R and Cu_1. (Greek λοφιά = a ridge).





Text-fig. 3. *Lophioneura ustulata*, n.g. et sp. Forewing. (x 16.7).
Text-fig. 4. Forewing of a large undescribed species of Psyllid from New Zealand, (expanse about 10 mm.).
For venational notation, *see* Text-fig. 1 above.

Affinities: In the complete fusion of the basal portions of M and Cu_1 with R, coupled with the small size, excessively simplified venational scheme and the very evident thickening of the costal margin from R_1 almost to apex, the forewing of *Lophioneura* shows very definite Sternorrhynchous characters,

though, at the same time, it is evidently of much more archaic formation than any type of Sternorrhyncha now known to exist. It is generally agreed that the *Psyllidae* are the most archaic of the existing Sternorrhyncha. Text-fig. 4 shows the forewing of an unnamed Psyllid of comparatively large size (expanse about 10 mm.) taken near Nelson, N.Z., which shows most of the archaic venational characters for the family. By comparing this with the venation of *Lophioneura* (Text-fig. 3) it will be seen that the following differences occur:—

(1) The Psyllid wing has become broader and more rounded; and, consequently, the costal margin has become strongly arched.

(2) In the Psyllid, Sc is degrading, and fails to reach the costal margin. (In some Psyllids, Sc is a short vein completely fused with the costa).

(3) The primary vein formed of the fused bases of R, M and Cu_1 is a strong ridge-vein equally in the Psyllid as in *Lophioneura*; but the amount of fusion of the three main stems which form it is much greater in the Psyllid, and there is a further fusion of the main stems of M and Cu_1, after leaving R, which is absent in *Lophioneura*. (In some Psyllids, however, this latter fusion is absent, M and Cu_1 leaving the primary vein at the same point).

(4) The origin of Rs from R_1 is placed much farther distad in the Psyllid, while the main stem of R has become much shorter and turns up more rapidly to join the costa. This last change is evidently correlated with the broadening of the wing.

(5) The very evident thickening of the costal margin in *Lophioneura*, which begins at the end of R_1 and reaches almost to the apex, is present in the same position in the Psyllid, but has become widened out into a coriaceous stigmatic area, broadest at R_1. The basal broadening of this area is again a change that is clearly correlated with the broadening of the wing.

(6) Rs has lost its fork. (If the position of the thickened costal area is a guide, it would appear that this has happened by suppression of R_{4+5}).

(7) M and Cu_1 have retained their forks, but that of M has widened in the Psyllid and altered in shape, while that of Cu_1 has altered very little indeed.

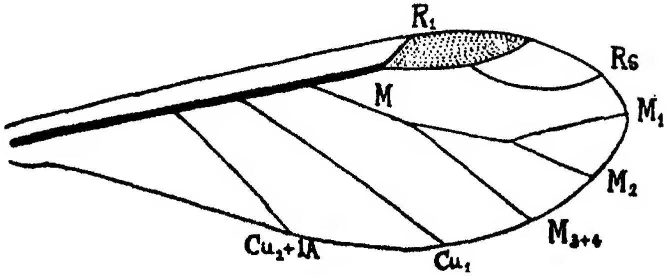
(8) While the vein $Cu_2 + 1A$ has altered little, the areas above and below it have broadened greatly. This again is clearly due to the general broadening of the wing.

I think that it will be admitted, from the above comparison, that the *Psyllidae* may be considered, as far as their forewing venation is concerned, to be direct descendants of the *Lophioneuridae*. Many authors have already pointed out that the Sternorrhyncha cannot be derived from the Auchenorrhyncha, owing to their possessing several more archaic characters than these latter. The Auchenorrhyncha have already been found in existence in the Newcastle Permian. We should naturally, then, expect to find the ancestors of the Sternorrhyncha existing alongside them, though the probability of such small wings being preserved is considerably less than in the case of the generally much larger Auchenorrhyncha. *Lophioneura* may, I submit, be legitimately considered to be a representative of this ancestral group.

From this same ancestral type, represented by *Lophioneura*, it is clear that, as far as the forewing is concerned, the *Aphiidae** can also be quite simply derived, though in a different direction from the *Psyllidae*. The line of evolu-

* *See* A. C. Baker, "On the Family Name of the Plant Lice." Proc. Ent. Soc. Washington, xxiii., No. 5., May, 1921, pp. 101-103, in which it is shown that the correct genitive of *aphis* is *aphios*, not *aphidos*, and hence the family name should be *Aphiidae*, not *Aphididae*.

tion leading to the *Aphiidae* must show a continuous tendency towards the narrowing of the wing-base, together with a steady movement of the points of origin of Rs, M and Cu_1 distad along the primary vein. Rs appears to be generally a simple vein in the *Aphiidae*, as in the *Psyllidae*. But, if we use the position of the thickened stigmatic area as a guide, it would seem that, in the *Aphiidae*, this simplicity has been attained by the suppression of R_{2+3}. The fact that the distal portion of Rs in the *Aphiidae* is concavely curved to the costa would also support this contention. Correlated with the narrowing of the wing basally, the primary vein in the *Aphiidae* becomes perfectly straight, and approaches near to the costa in position. $Cu_2 + 1A$, on the other hand, becomes fused with the primary vein, and moves upward, following the distal movement of Rs, M and Cu_1. In some forms an extra fork appears on M_{1+2}, but has not yet become fixed in every case. (I have seen this extra fork *on one forewing only*, not only in *Aphiidae*, but also occasionally in *Psyllidae*). Text-fig. 5 shows the typical venation of the forewing of an Aphid, for comparison with Text-figs. 3 and 4.



Text-fig. 5. Diagram of the venational scheme in the forewing of the Family *Aphiidae*, showing M with the extra branch present.
For venational notation, *see* Text-fig. 1 above.

It would seem, then, reasonable to recognise in *Lophioneura* a highly archaic Sternorrhynchous type, (probably standing quite close to the archetype of the group), from which, through the long period of geological time between the Upper Permian and the first appearance of the true *Psyllidae* and *Aphiidae*, changes along two different evolutionary lines have led to the venational types of these two families.

LOPHIONEURA USTULATA, n.sp. (Plate xxxv., fig. 2; Text-fig. 3.)

Forewing: Length, 5.7 mm; breadth, 1.9 mm.

The specimen is the cast of a complete right wing, lying longitudinally upon the midrib of a small frond of *Glossopteris* sp., the base of the wing being towards the apex of the frond, and 10 mm. from it. (*See* Plate xxxv., fig. 2). The impression is perfect, but for slight indistinctness of the basal portion of the costa and of a portion of M_{1+2}, where the rock appears to have been scraped. The costal margin is delicately formed from base up to end of R_1, but from there on almost to apex it is strongly formed, and appears to be made up of the true costa fused with R_1, which, in that case, must be assumed to run on well beyond its apparent termination on the costa. At the point where R_{2+3} ends up, this strong costal vein broadens out a little to meet it, and then runs strongly on for about two-thirds of the distance between the two branches of Rs, where it ends.

Type in Mr. John Mitchell's Collection.

Locality.—Burnt shale from the embankment of the railway at Merewether Beach, near Newcastle, N.S.W.

The specific name indicates the burnt condition of the rock on which the impression was found, with the addition of a diminutive in allusion to the small size of the wing (Latin, *ustus* = burnt).

The discovery of the two fossils described above leaves the known history of the Hemiptera in late Palaeozoic times in a very interesting condition. True Homoptera belonging to the Division Auchenorrhyncha have already been discovered in the Upper Permian, viz. *Permoscarta*, belonging to the *Scytinopteridae*, and *Permofulgor* representing the monotypic family *Permofulgoridae*; the former was found at Newcastle, N.S.W., the latter at Belmont, at a somewhat higher horizon. Thus we now know four very distinct types of Upper Permian Hemiptera from Australia, if my determinations of the systematic positions of these fossils are correct. To these may be added the two known Upper Permian genera from Russia, viz. *Prosbole* and *Scytinoptera*. We thus get the following classification for the Order in Upper Permian times:—

Suborder **Palaeohemiptera.**

A single family, *Prosbolidae.*

Genera *Prosbole* (Russia), *Mitchelloneura* (Australia).

Suborder **Homoptera.**

Division AUCHENORRHYNCHA.

Family *Scytinopteridae.*

Genera *Scytinoptera* (Russia). *Permoscarta* (Australia).

Family *Permofulgoridae.*

Genus *Permofulgor* (Australia).

Division STERNORRHYNCHA.

Family *Lophioneuridae.*

Genus *Lophioneura* (Australia).

The Suborder Heteroptera had apparently not yet been evolved. As I had previously pointed out, in dealing with the Upper Triassic family *Dunstaniidae*, which is the oldest known type of true Heteroptera, their origin is to be looked for in the Palaeohemiptera, from some type a little earlier than *Prosbole* itself (Tillyard, 1918, p. 589). The discovery of the genus *Mitchelloneura* shows that the ancestral type there postulated was probably present in Australia in Upper Permian times, just as the ancestors of the Upper Triassic Homoptera of Australia were already present there at that same period.

The fact that the Homoptera were already specialised into their two main Divisions in Upper Permian times indicates a considerably earlier origin in geological time for the Order Hemiptera as a whole. This indication is borne out by the occurrence, in the Upper Carboniferous of Commentry, of a fossil forewing, left unclassified by Handlirsch (1908, p. 325, and Atlas, Pl. xxxiv., fig. 1) which Professor Lameere and myself both agree, after studying the specimen itself, should stand close to the earliest beginnings of the Order, but definitely within it. This fossil is *Dictyocicada antiqua* Brongniart. We are thus led to envisage the Order Hemiptera as a highly specialised but exceedingly ancient offshoot of some more generalised Upper Carboniferous Order, which already possessed the stegopterous or roof-like manner of folding the wings. This Order must surely be the Protorthoptera of Handlirsch, in which so many diverse types are known to have occurred that they may well form

the starting-point, not only of the Hemiptera, but of many other Orders existing at the present day.

Literature Quoted.

HANDLIRSCH, A., 1908.—Die Fossilen Insekten. Leipzig. (*Prosbole*, p. 390, and Atlas, Pl. xxxvii., figs. 24, 25; *Dictyocicada*, p. 325, and Atlas, Pl. xxxiv., fig. 1.)

TILLYARD, R. J., 1918.—Mesozoic Insects of Queensland. Part 4. Hemiptera Heteroptera: the Family *Dunstaniidae*. *Proc. Linn. Soc. N.S.W.*, vol. xliii., 1918, pp. 568-592, pl. lix.

Cawthron Institute, Nelson, N.Z.
August 9th, 1921.

EXPLANATION OF PLATE XXXV.

Fig. 1. *Mitchelloneura permiana*, n.g. et sp., hindwing. (x 6.7).

Fig. 2. *Lophioneura ustulata*, n.g et sp., forewing, lying upon a portion of a frond of *Glossopteris* sp. (x 16.7).

ORDINARY MONTHLY MEETING.

26TH OCTOBER, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Dr. A. Eland Shaw, Wynnum South, Queensland, was elected an Ordinary Member of the Society.

The President announced that the Council is prepared to receive applications for four Linnean Macleay Fellowships, tenable for one year from 1st April, 1922, from qualified Candidates. Applications should be lodged with the Secretary, who will afford all necessary information to intending Candidates, not later than 30th November, 1921.

A letter was read from Mr. H. Burrell, returning thanks for congratulations on the success of his collecting.

The Donations and Exchanges received since the previous Monthly Meeting (28th September, 1921), amounting to 7 Vols., 54 Parts or Nos., 4 Bulletins, and 2 Reports, received from 31 Societies and Institutions and two private donors, were laid upon the table.

NOTES AND EXHIBITS.

Dr. R. J. Tillyard exhibited a set of five fossil insect wings recently discovered by Messrs. J. Mitchell and T. Pincombe in the Upper Permian Insect Beds of Belmont. Three of the specimens are wings of the Scorpion-fly *Permochorista* Till., already known from these beds. There is also a fine Lacewing, evidently ancestral to quite a number of families of Planipennia existing in Australia to-day, and the first record of the Order Planipennia older than Upper Triassic. The fifth wing is only about 3 mm. long, represents a new family of the Sternorrhynchous Homoptera, and is clearly closely allied to both the *Aphiidae* and *Psyllidae*.

Mr. W. W. Froggatt exhibited a living specimen of a chalcid wasp, *Dinoura cyanea* Ashm., bred from the gall of *Apiomorpha ovicola;* also mounted specimens of this and a second species *D. auriventris* Ashm. These chalcid wasps are remarkable for the extraordinary prolongation of the abdomen in the female which terminates in a three-flanged process. They are inquilines in the coccid gall cavity, forming a cell in the base in which they pupate.

Mr. Froggatt also exhibited a specimen of the Frog Warble fly (*Brachiomyia nigritarsus* Skuse). The infested frog was received from Mr. T. Steel on 31st August. It emerged from the warble on the frog's back on 1st September, buried itself in the damp soil and pupated the next day. The perfect fly emerged on 10th October and was kept alive for ten days in a glass tube, being fed on sugared water.

Mr. G. H. Hardy exhibited three ichneumon parasites which prey upon spiders, all apparently belonging to the same genus. They belong to the tribe *Pimplides* and one Queensland specimen was provisionally labelled by Mr. H. Hacker, Entomologist of the Queensland Museum as "*Eriostethus* or near." The specimens were as follows:—1 ♂ and 1 ♀ from Tasmania, from which State they have been bred from larvae attached externally on the abdomen of spiders; two ♂ with their cocoons from Queensland, one bred from the larva and one from the pupa; and finally one specimen taken in the act of ovipositing upon a spider at Como, N.S.W., on the 8th October, 1921. Previous records of the Tasmanian species will be found in the abstracts of proceedings of the Royal Society of Tasmania for 1914 (p. 89) and 1915 (p. 113 No. 1).

Mr. Hardy exhibited another Tasmanian ichneumon which was also mentioned in the 1915 reference (No. 4). This species is parasitic upon large sawfly larvae of the genus *Perga*. When attacked the sawfly larvae discharge their well known and repulsive liquid; should the ichneumon be hit by this sticky matter it will fall to the ground, being unable to utilise its wings and several hours are necessary for the ichneumon to cleanse itself and renew the attack. It is quite interesting and often exciting to watch two or three of these ichneumons attacking a cluster of saw-fly larvae; they worry the larvae and evade, not always successfully, the retaliating discharge which diminishes in quantity in each successive volley. When the cluster has finally run out of ammunition the ichneumon may still be loth to alight upon its prey for a considerable time —perhaps making sure that the larvae are not reserving their last shot.

STUDIES IN LIFE-HISTORIES OF AUSTRALIAN DIPTERA BRACHYCERA.

Part i. Stratiomyiidae.

No. 3. On the structure of the mouth-parts and pharynx of the larval *Metoponia rubiceps*.

By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

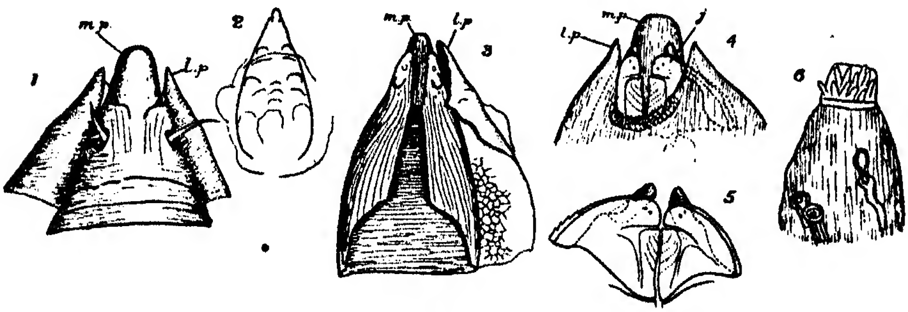
(Plate xxxiii., and twenty-six Text-figures.)

No satisfactory description exists of the mouth-parts of any larval *Stratiomyiidae* other than a few aquatic species. Vaney (1902) and Jusbaschjanz (1910) have done some work on the genera *Stratiomyia* and *Odontomyia*; and Becker has taken the genus *Stratiomyia* as the type of the family *Stratiomyiidae* in his general account of the mouth-parts of Dipterous larvae (1910). But many of the features present in this genus, such as the great development of tufts of hairs on the jaws, must be regarded as highly specialised adaptations to the aquatic mode of life, and a more typical form must be looked for in the soil-inhabiting species. Very few attempts have been made to study these in detail. Tragardh's description of *Pachygaster minutissima* (1914) contains a brief account of the head and mouth-parts, with several figures, which, unfortunately, are not very clear. He points out the difficulty of getting a good idea of these structures, and of their homology with those of other fly larvae. Indeed, most Dipterologists, from Brauer onwards, who have studied the larval forms, mention the great technical obstacles in the way of their elucidation. The parts are all very minute, and are composed of such dense chitin that the clearing, sectioning, or dissection of them seldom gives good results. The knowledge of the mouth-parts of the whole group of Diptera Brachycera is, for this reason, very meagre. Brauer, forty years ago, made an excellent comparative study (1883) of the material then at his disposal, and Becker has since contributed (1910) some additional information on the same subject, from the study of a few more representatives of the different groups. But he, too, draws attention to the paucity of the data on which to make generalisations and to interpret the nature of the separate mouth appendages. Therefore, until the larvae of all the families of Brachycera have been studied in greater numbers of species, and in greater detail, I do not think it possible to add anything of value in this connection; and, for this reason, I have not attempted, in the following description, to compare the various structures with those described in other Stratiomyid larvae, and in the larvae of any other of the Brachycera.

The *Stratiomyiidae* belong to that group of fly larvae characterised by having parallel jaws, working upwards, or outwards, and downwards, as distinguished from those with opposing, horizontally moving mandibles. The adaptation accords with their method of obtaining nourishment by suction, instead of by biting and chewing; and the larval *Metoponia rubriceps*, which lives on the juices in the roots of grasses, shows this feature very well. A brief description of the mouth-parts is contained in the first paper of this series (Irwin-Smith, 1920). The present paper gives the results of more detailed morphological investigations.

Mouth-parts.

Bounding the upper side of the oral aperture is a smooth, cylindrical, peg-like process, the median process (*m.p.*). It is not movable, and is really the terminal apex of the shield-shaped sclerite which covers the greater part of the dorsal surface of the head (Text-fig. 2). At the base of the median process the lateral edges of the sclerite bend inward and downward into the interior of the head, forming a sort of internal skeleton, and enclosing a cavity which continues up into the median process (Text-fig. 3). The process appears to be a composite structure, formed by the fusion of a median and two side pieces. On the ventral side, where the fusion is incomplete, two longitudinal slit-like apertures communicate with the hollow interior of the process. Laterad of these are two downwardly directed knob-like projections. On the dorsal surface, the anterior extremity of each side piece is marked by a ridge, and immediately in front of this is inserted a fine hair (Text-fig. 1). A similar, but somewhat larger hair is situated further back, in a deep circular depression. The median process measures about 0.03 mm. across the tip, and 0.14 mm. from tip to base on ventral side. The whole sclerite, including the median process, and the internal ridges, is composed of very dense, dark brown chitin, and can be dis-



Text-figures 1–6.

1. Dorsal view of anterior end of head. (x 120). 2. External view of dorsal sclerite. (x 32). 3. Internal view of the same, with one lateral plate still attached. (x 66). 4. Ventral view of mouth parts. (x 120). 5. Mouth jaws. (x 166). 6. Portion of cuticular wall just below ventral processes showing glandular apertures (?). (x 320).

j, jaw; *l.p.*, lateral plate; *m.p.*, median process.

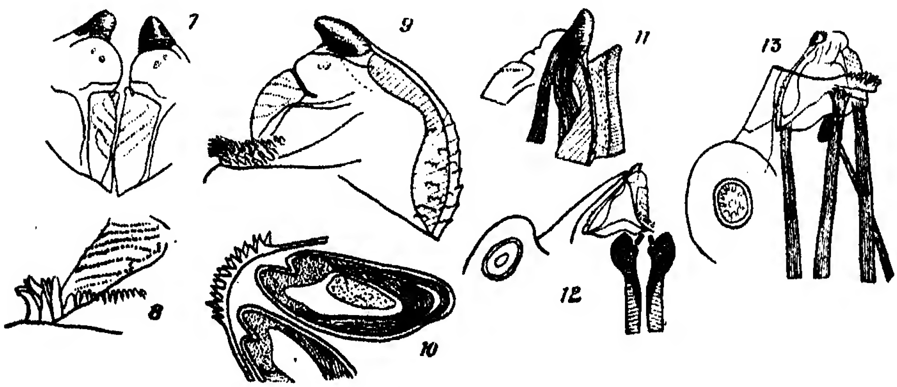
sected away from the remaining parts of the head in a single piece (Text-fig. 2). Posteriorly, it is connected up with the sides of the head by a stout, membranous cuticle, having an armour of hexagonal plates somewhat similar to those on the body (Text-fig. 3). Further up, it is firmly fused with the dense chitin which forms the lateral "bosses" and extends forward in the shape of two

sharply-pointed lateral plates (*l.p.*). These plates, although firmly united with the median process, in such a way as to allow of no separate movement, can be broken away from it fairly readily, when the parts are dissected out. From their hard, strong apices they extend downward in a deep curve, to unite in the ventral median line in a structure of much softer composition, which forms the ventral boundary of the oral aperture. Its edge is fringed with several rows of soft processes (Text-fig. 4).

Immediately below these processes, there is, in the cuticle, a group of what appear to be the openings of ducts. A pair of these is situated close to the centre line, with two more on each side a little further back (Text-fig. 6).

The lateral plates are hollowed out to form sheaths, or sockets, for the two movable mouth jaws (Text-figs. 5, 9). These jaws, although very minute, less than a tenth of a millimetre long, have a very complicated and interesting structure. In form they are somewhat conical, having a broad oval base (Text-fig. 10) and a pointed apex. The apex consists of a single, relatively large (0.026 mm. long) tooth of dense chitin, which rests on, and articulates with the chitinous internal framework which strengthens the back part of the jaw (Text-fig. 11). This framework serves, also, as the point of attachment for the muscles which move the tooth. With the exception of these chitin structures, and another chitin mass at the base, the entire jaw is composed of several distinctly marked off areas of clear, colourless composition.

Below the tooth is a soft, rounded, cushion-like swelling, having on its outer face two small, oval patches, which appear to be of the nature of sensory papillae. A deep groove separates this swelling from a plate which bears on



Text-figures 7–13.

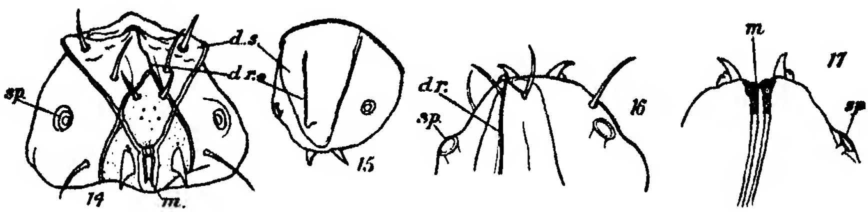
7. Inner edges of the two jaws. (x 280). 8. Denticles of jaw. (x 320). 9. Side view of entire jaw. (x 280). 10. Transverse section through lower part of jaws. (x 280). 11. Apical tooth of jaw, showing attachments of muscles which move it. (x 200). 12. Oral termination of pharynx, showing the pillars which support the jaws. (x 120). 13. Attachments of muscles which move the whole jaw. (x 120).

its outer face from five to seven transverse rows of minute denticles (Text-figs. 7, 8, 9). The denticle plate extends to that part of the jaw which is nearest to the opposite jaw, but does not continue round its inner face; so that the denticles of the two jaws are hardly opposable. On the back of the jaw, where it moves in the socket of the lateral plate, the cuticle is raised into a series of serrated ridges (Text-fig. 9).

The whole jaw is supported by its base on a central chitinous peg, which acts as a pivot on which the jaw can move with a rocking movement. The muscles which move it are shown in Text-fig. 13. They extend back through the head for some distance, to be inserted posteriorly in the head wall. Average measurements for the jaw are 0.088 mm. from apex to base, and 0.085 mm. in diameter from front to back.

The pivots on which the jaws work form part of the chitinous wall surrounding the anterior end of the pharynx. The oral aperture is situated just at the base of the median process, where the latter opens out into the internal cavity of the head (Plate xxxiii., fig. 1*a*) and here the strongly chitinised rim of the pharynx grows up on each side, in the form of a stout, curved, pointed pillar (Text-fig. 12) to support the jaw. Lying free between these, in the oral opening, are two very small blocks of chitin. The opening is quite concealed by the overlying jaws and processes, and is only revealed by careful dissection.

In his description of the mouth parts of Stratiomyid larvae which he had examined, Becker makes the statement that there is no median mouth opening, and that nourishment is taken in through the lateral slits in the walls



Text-figures 14–17.
Drawn from cast skins of first ecdysis.
14. Front view of head, showing terminal mouth, and jaws. (x 320). 15. General view of head, from antero-dorsal aspect. (x 190). 16. Anterior part of head, dorsal view. (x 320). 17. Internal view of same, showing pharynx. (x 320).
d.r., dorsal ridge; *d.s.*, dorsal sclerite; *m.*, mouth; *sp.*, spiracle.

of the median process which, he suggests, has been formed by the coalescence of upper and lower lips. That this is not the case with the larva of *Metoponia rubriceps* is very clearly shown by an examination of cast larval skins, found with the empty egg cases and newly hatched larvae. These skins have been described in the second paper of this series (Irwin-Smith, 1921). The cast of the head retains the original shape and position of all the parts, and is very interesting as showing an earlier stage of development than is seen in the hatched larva itself. In the cast skin the mouth opening is quite terminal in position, and is bounded only by the two stout jaws (Text-figs. 14-17). Of the lateral chitin plates, which afterwards ensheath them, there is here no trace. The dorsal sclerite is already well developed and clearly marked off by a thickened rim (*d.s.*). In the middle of the sclerite there is a longitudinal ridge (*d.r.*) which terminates towards the anterior end in a short, pointed outgrowth. This is evidently the rudiment of the median process. A careful examination of the position of the hairs surrounding it seems to show that the median process of the fully-developed larva is formed from it, by the overgrowth of this portion of the sclerite and a pushing forward of the process on to the part of the sclerite lying in front of it, and its fusion with the side walls. The skins being

very minute, the exact structure of the parts can only be made out with difficulty, under high magnifications; and for a full working out of the details of development, a complete series of the embryonic stages would be required. Unfortunately, I have been able to hatch out only one batch of eggs, and of these, have only the last stage, immediately before hatching, for examination. At hatching, the mouth parts of the larva differ very slightly from those of the older larvae. Some dozen or more skins were obtained, closely tangled up with the empty egg mass; and all show exactly the same stage of development.

In the casts, the terminal portion of the pharynx is already surrounded by a thickened outgrowth of chitin, but from this point the pharynx runs back through the head as a simple structure of uniform width (Text-fig. 17). None of the skins contain any trace of an internal chitinous skeleton, or indication of the presence of the masticatory apparatus, which is such a prominent and characteristic feature of the larva.

The Pharynx. (Plate xxxiii., figs. 1-5, and Text-figures 18-26.)

Vancy, Becker, and Jusbaschjanz have described this apparatus (called by them the "Schlundkopf") as it appears in the aquatic larvae which they examined; and Jusbaschjanz has studied it by means of transverse sections, and has given some figures of it. It is a highly complicated and beautifully adjusted piece of mechanism, and requires a good deal more study than has been given to it. The figures and descriptions already published are not very clear, but in *Metoponia rubriceps* the apparatus seems to differ somewhat, in form and structure, from those previously described. Satisfactory sections through this part of the larva are difficult to obtain. The chitin composing it is so dense and brittle as to defy all attempts to soften it sufficiently for the microtome, and the parts become shattered in the cutting. Dissections show the relationships of the various parts very well, but the study of transverse sections has necessitated much careful reconstruction, after detailed examination of long series of torn fragments.

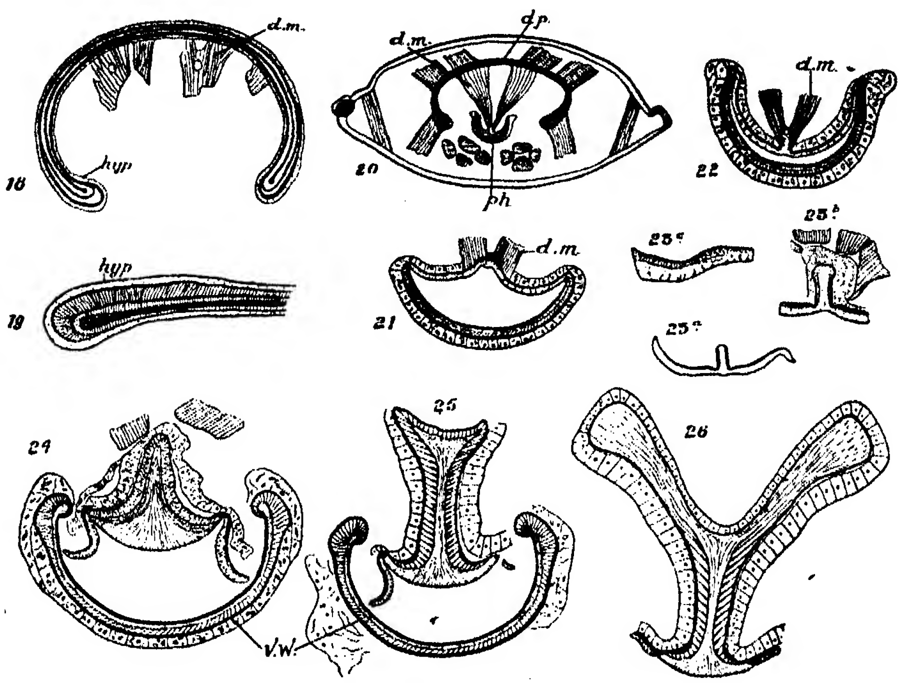
As in all Stratiomyid larvae, the dorsal sclerite of the head is continued back through the first thoracic segment as an internal skeleton in the form of a dorsally convex arch, the dorsal head plate (*d.p.*). It extends to the middle of the second segment, and is firmly held in position by means of powerful muscles attached to the body wall, which are shown in Text-fig. 20 and Plate xxxiii., fig. 1. Its ventral surface serves as the point of attachment for the dilator muscles of the pharynx (*d.m.*).

The pharynx (*ph.*) lies in the space between its lateral margins, and terminates posteriorly about the middle of the first segment, in the complicated masticatory apparatus already referred to. From this, the slender, thin-walled oesophagus passes straight back, below the dorsal plate, to open into the proventriculus at the level of the third thoracic segment (Plate xxxiii., fig. 5).

In transverse sections, stained with haematoxylin and eosin, the dorsal head plate is seen to consist of several layers of chitin (Text-fig. 18). In cutting, it frequently splits apart, along the middle line, into an upper and lower portion, of equal width, each part graduating from a pinkish colour on the inside to a dark yellowish brown on the outside; and in contact with the latter layer all round, dorsally and ventrally, is a layer of hypodermis. The lateral edges are rounded and thickened, with an additional layer of brown chitin along the upper surface (Text-fig. 19).

Anteriorly, the walls of the dorsal sclerite close in on the pharynx, but, so far as I can make out, there is no connection with it such as Jusbaschjanz

describes in the larvae of *Stratiomyia* and *Odontomyia*. The pharynx seems to lie free in the head cavity throughout its length. It is bow-shaped in transverse section, the string of the bow representing the dorsal wall (Text-fig. 21). Its ventral wall consists of a deeply arched piece of chitin, in two layers, the inner



Text-figures 18–26.

Transverse sections, showing the structure of dorsal head plate and pharynx.

18. Dorsal head plate. (x 66). 19. Lateral margin of head plate (x 160). 20. T.S. through 1st thoracic segment in region of spiracles. (x 32). 21. Pharynx, in region of head. (x 120). 22. Pharynx, further back. (x 120). 23*a*. Dorsal wall of pharynx. (x 130). 23*b*. Median ridge of same. (x 200). 23*c*. Portion of wall. (x 320). 24-26. Pharynx in region of "wing-bearer." (x 160).

d.m., dilator muscles of pharynx; *d.p.*, dorsal head plate; *hyp.*, hypodermis; *ph.*, pharynx; *v.w.*, ventral wall of pharynx.

pink, the outer yellowish-brown. Its lateral rims are strongly thickened and knob-like, and bounding it externally is a thick layer of hypodermis, consisting of a single row of cells.

The dorsal wall is of quite different composition, consisting of a substance which appears to be of a tough, elastic nature, and stains a deep blackish brown. It, also, is bounded externally by hypodermis. Along its median line are inserted the twelve or fourteen pairs of dilator muscles, which stretch between it and the dorsal wall (*d.m.*). By their contraction, these muscles evidently enlarge the cavity of the pharynx, and cause it to act as a powerful sucking apparatus.

The effect is augmented by the action of the peculiar mechanism at the posterior end of the pharynx. This is a greatly thickened chitin structure, wedge-shaped in ventral view, with broad base at the posterior end (Plate xxxiii., figs. 3, 4). It takes the place of the dorsal pharyngeal wall, and projects, by its downwardly curved under surface, into the space enclosed by the crescentic ventral pharyngeal wall. It is attached to the ventral wall on each side by a tough, dark-staining membrane, which appears to be similar in composition to the dorsal wall higher up. Dorsally it projects upwards and outwards in the form of two broad, stout, wing-like processes. Two powerful muscles, attached to each wing, extend backwards to be inserted in the posterior margin of the dorsal head plate (Plate xxxiii., figs. 1, 2). By the contraction of these muscles the upper part of the "wing-bearer" would be pulled outward and downward, while its base would work against the face of the ventral wall (Plate xxxiii., fig. 4). Apparently the reverse movement is effected by the elasticity of the ligaments connecting it with the pharynx anteriorly and laterally. I cannot detect the presence of antagonistic muscles, although such muscles are described by both Vaney and Jusbaschjanz. But, as the "Schlundkopf," or masticatory apparatus, examined by them was globular in form, it will be seen that the details of its structure and relationships must necessarily be somewhat different. I have not been able to find anything to correspond with the lateral chitin plates which Jusbaschjanz describes as projecting up from the basal plate of the wing-bearer, and connecting dorsally with the forked median plate which bears the wings. However, as I have experienced great difficulty in cutting this apparatus and have not been able to get a complete series of sections, I cannot speak with certainty of its structure throughout its entire length, or of the exact way in which it connects with the dorsal pharyngeal wall anteriorly. The figures of transverse sections given here represent careful reconstructions of those parts which I have been able to study in detail.

In the region of the pharynx immediately anterior to the "wing-bearer," the dorsal wall has the appearance shown in Text-figures 22, 23. There is here a short median process, to which the pairs of dilator muscles are attached, and which differs but little in composition from the rest of the dorsal wall.

Text-figures 24 to 26 represent transverse sections through different parts of the wing-bearer itself. The first tapers from the broad base to a point dorsally; the next shows a broadening and slight forking of the dorsal portion, the third the expansion into the two "wings." To the angles of the base are attached the ligaments which connect it with the ventral wall, here seen torn away from their connections in the sectioning. A broad layer of hypodermis covers the dorsal surface of the whole structure, and is continued along the connecting ligaments. The "wing-bearer" consists of an outer layer of chitin, staining dense brown, merging towards the interior into a clear pink, which encloses a central core of much lighter and apparently softer composition. It seems to be made up of a loose fibrous material, which is so transparent that, in surface view, the wing-bearer has the appearance of being hollowed out in the middle. But in transverse sections it is seen that this core broadens out into a base which is deeply convex.

In all the sections which I have examined, this base and the ventral plate present firm, smooth surfaces to each other, but in the posterior part of the apparatus there is a roughened appearance, suggesting denticles or other tooth-like structures, on a much denser foundation, which I did not succeed in sectioning.

The wing-bearer measures 0.33 mm. in length, with a breadth of 0.30 mm. to the tip of the wing.

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EXPLANATION OF PLATE XXXIII.

Sucking apparatus of larva of *Metoponia rubriceps.*

Fig. 1. Dorsal view of head and 1st thoracic segment, showing systems of muscles controlling dorsal head plate and pharynx. (x 48).

Fig. 1*a*. Oral termination of pharynx. (x 190).

Fig. 2. Lateral view of dorsal head plate and muscles of pharynx. (x 48).

Fig. 3. Ventral view of posterior end of pharynx, showing wing-bearer. (x 100).

Fig. 4. Lateral view of same. (x 100).

Fig. 5. Anterior half of larva, giving a general view of the anterior portion of the alimentary system. (x 15).

c., chitin support for jaw; *d.*, dorsal muscles of head plate; *d.m.*, dilator muscles of pharynx; *d.p.*, dorsal head plate, *e.*, edge of internal skeleton of dorsal sclerite; *oe.*, oesophagus; *pv.*, proventriculus; *v.*, ventral muscles of head plate; *w.*, muscles of wing-bearer; *w.b.*, wing-bearer; *v.w.*, ventral wall of pharynx.

NEW AND RARE AUSTRALIAN TERMITES, WITH NOTES ON THEIR BIOLOGY.

By Gerald F. Hill, F.E.S.

(Plate xxxvi., and fifty-two Text-figures.)

During recent years and since the publication of Froggatt's monograph (1895-6) about 63 species have been added to the list of Australian Termites, bringing the total, inclusive of 5 species described in this paper, up to approximately 115. Of this number no fewer than 49 have been described during the past two years.

In the following descriptions Ridgway's Colour Standards and Nomenclature has been used as far as possible; measurements of wings are from the suture to the apex and across the widest part; all examinations were made in daylight and all figures drawn with the aid of a camera lucida; measurements are in millimeters.

The types of new species are in the writer's collection; the drawings for the Text-figures were made by the author.

Subfamily STOLOTERMITINAE.

Genus Stolotermes Hagen.

Stolotermes victoriensis, n.sp. (Figs. 1-11.)

Imago. (Figs. 1-7).

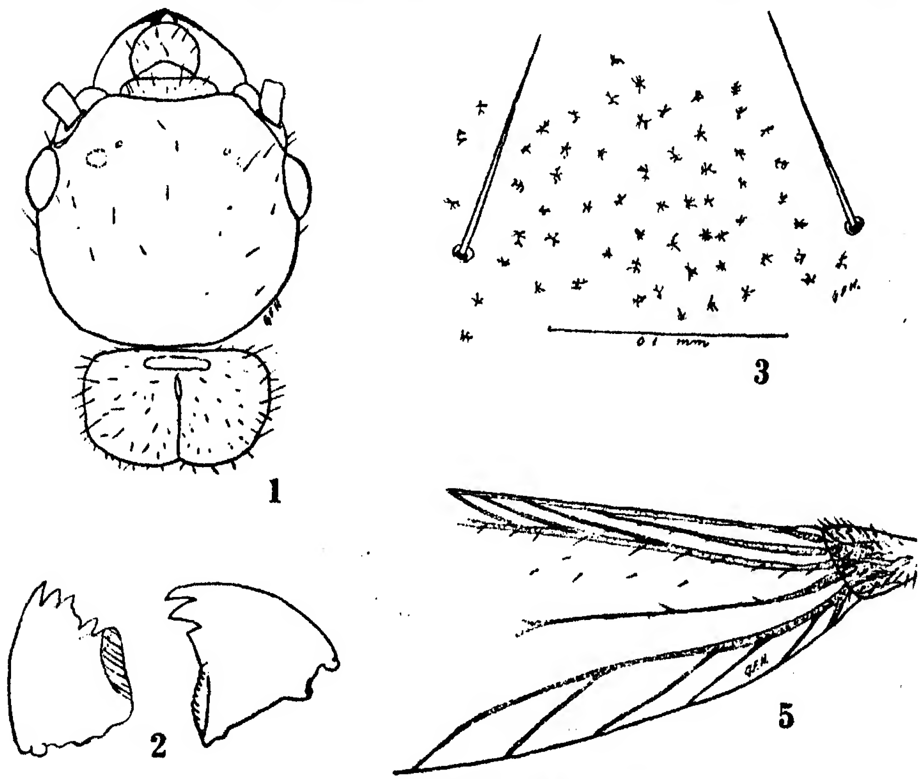
Colour: Head, thorax, abdomen, antennae and palpi dark brown, proximal joints of antennae lighter than others; clypeus and labrum ochraceous tawny; legs buckthorn brown suffused with dark brown, mandibles ferrugineous. Wings very dark brown, blackish when folded.

Head (Fig. 1) large, rounded behind and on the sides, widest across the eyes, flat on the summit, without median suture, clothed scantily with moderately large setae. Labrum large, rounded, not covering apical teeth of mandibles. Clypeus short and wide, anterior margin membranous. Eyes small and very prominent, a little higher than wide (.235 x .282), surrounded by pale-coloured membrane. Ocelli invisible except in cleared preparations, then very indistinct. A small deep depression on either side of the median line in line with the insertion of the antennae and immediately posterior to the postero-lateral angle of the clypeus. Mandibles (Fig. 2) with four angular teeth on the left and two angular and one broad tooth on the right. Antennae (Fig. 7) 16-jointed,

3rd joint shortest of all, equal to, or noticeably longer than 4th, 5th-10th increasing in length and width, 10th-14th equal in length, 15th a little shorter, 16th shorter, elongate-oval. (In one example there is a rudimentary segment between the 3rd and 4th as described above).

Thorax: Pronotum very small, much narrower than head, nearly straight in front and on the sides, antero-lateral angles rounded, sides narrowed to the slightly sinuate posterior margin; behind the anterior margin a wide, pale, transverse mark, median suture distinct and passing posteriorly through the meso- and metanotum as a very dark line, clothed with scattered, long setae, most numerous at the sides. Meso- and metanotum with posterior margin nearly straight.

Wings (Plate xxxvi., Fig. 4) very dark brown, veins darker than membrane, the whole surface densely sculptured (Fig. 3) and clothed with dark, scattered setae, numerous along the costal margin excepting on the proximal one-third. Subcosta of forewing very short, joining the costa beyond the suture, wanting in the hindwing. Radius short, about one-fourth the length of the wing.



Stolotermes victoriensis, n.sp. Imago.
Fig. 1. Head and pronotum. Fig. 2. Mandibles. Fig. 3. Wing membrane. Fig. 5. Stump and base of forewing.

Radial sector very short with 8 to 10 superior branches to the radius, that of the forewing branching from the media proximad of the suture, that of the hindwing distad of the suture. Media traversing the middle of the wing, dis-

tinct only at the base, with about 6 inferior branches to the posterior margin of the wing. Cubitus with about 6 short, stout branches. Wing stumps (Fig. 5) with numerous long, pale setae, base of veins distinct, suture oblique, those of forewings larger than, but not reaching those of, hindwing.

Legs (Fig. 6) rather short and stout, with scattered, fine setae; empodium small; tibial spines 3: 3: 2, not serrate.

Abdomen long and narrow, bluntly rounded at the apex. Cerci very prominent (.282 long), 3-jointed. Styli present in male.

Measurements:

Length with wings 11.0, without wings 6.5.

Head: at and including eyes, wide 1.222; base to base of clypeus, long 0.990; base to apex of mandibles, long 1.363.

Antennae (16-jointed) 2.350.

Mandibles: left, long .517, wide .329; right, long .470, wide .470.

Pronotum: long 0.50; wide 0.80.

Wings (from suture): forewing, long 9.00, wide 2.82; hindwing, long 8.50, wide 2.82.

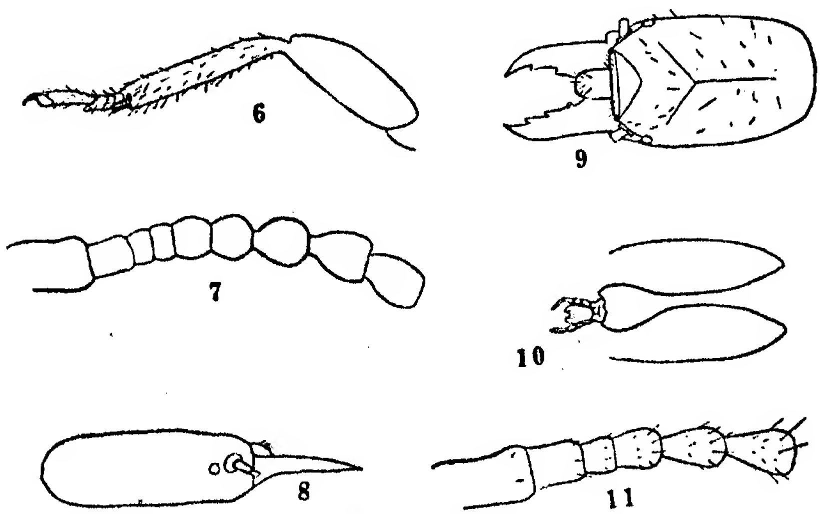
Abdomen, wide 1.50.

Queen.

Lighter coloured than imago. Length 7.25; antennae mutilated, 7 joints.

Soldier. (Figs. 8-11.)

Colour: Cadmium yellow, a little darker in front; labrum like back of head; antennae paler; mandibles and spot at postero-lateral angle of clypeus



Stolotermes victoriensis, n.sp.

Figs. 6-7. Imago. 6. Hind leg; 7. Antennae, proximal segments.
Figs. 8-11. Soldier. 8. Head in profile; 9. Head from above; 10. Gula; 11. Antennae, proximal segments.

light castaneous, anteclypeus membranous; legs cream; abdomen lighter, with brown pattern along medial line of dorsum.

Head (Figs. 8 and 9) long, rounded behind, slightly curved on the sides, a little wider anteriorly than behind, very flat in profile, "Y" suture distinct, with a few reddish setae. Labrum large, longer than wide, truncate at the apex. Clypeus more or less triangular. Gula (Fig. 10) very long, narrow in the middle, one-tenth the width of head. Mandibles very long, with two broad and one narrow teeth on the left and two broad teeth on the right. Eyes small and indistinct, adjacent to antennal fossae. Antennae (Fig. 11) mutilated, more than 14-jointed, 3rd joint shortest, sometimes 3rd and 4th nearly equal, 5th-10th increasing in length successively, slender.

Pronotum as in imago, but with scanty, moderately stout, reddish setae.

Legs short and moderately stout. Tibial spines 3: 3: 2.

Abdomen elongate oval, bluntly pointed at the apex.

Measurements:

	(*a*)	(*b*)	(*c*)
Total length	7.00	8.50	9.50
Head, from base to apex of labrum, long	2.444	2.679	2.773
Head, from base to apex of mandibles, long	3.290	3.290	3.570
Head, deep	0.611	—	—
Head, wide	1.410	1.730	1.833
Pronotum, long	0.470	0.564	0.564
Pronotum, wide	0.750	0.987	0.987
Tibia iii.	0.658	0.987	1.081
Abdomen, wide	1.269	—	—

The above measurements are those of the only soldiers found in the type colony. The description and figures are from (*a*), which appears to me most probably the normal form. (*b*) and (*c*) have the head distinctly wider and more rounded, pigmented eyes, and, respectively, moderately long and very long wing rudiments. The latter are thickened and clothed with long reddish setae. Styli are present in all three.

Larvae and Nymphae.

Several developmental stages are distinguishable, as follows:—

(1). Larvae, 3.05 long, 11-jointed antennae, joints 2 and 3 fused, eyes and wing rudiments wanting.

(2). Larvae, 5.00-5.50 long, 12-jointed antennae, joints 2 and 3 fused, eyes just visible, slightly pigmented, wing rudiments wanting.

(3). Nymphae, 6.00 long, 13-jointed antennae, joints 3, 4 and 5 closely fused, eyes very indistinct, slightly more pigmented than (2), wing-rudiments very small, cream coloured.

(4). Nymphae, 6.50 long, 15-jointed antennae, joints 3 and 4 fused, eyes black, wing rudiments distinctly visible, setaceous.

Described from a small colony comprising eggs, larvae, nymphae, mature and immature alate forms, soldiers and queen, taken in a rotten log on 1st January.

In his recent paper Mjöberg (1920) described two new species in this genus, *Stolotermes queenslandicus* and *St. australicus*, from the tropical forest of Atherton District, North Queensland. Previously the genus contained only two species, *St. brunneicornis* Hagen, from Tasmania (alate forms only) and *St. ruficeps* Brauer, from New Zealand.

Affinities.—This species is evidently closely allied to *St. brunneicornis*, from which it differs in having no evident median suture in the head, no median false ocellus-like spot between the eyes, and distinctly different antennae. In length,

with wings, Hagen's species exceeds that of the new species by 2 mm.

Loc.—Victoria: Beaconsfield (F. E. Wilson).

Subfamily CALOTERMITINAE.

Genus POROTERMES Hagen.

POROTERMES ADAMSONI (Froggatt).

These Proceedings, xxi., 1896, p. 532.

This species, originally described from specimens from New South Wales (Uralla), has not been recorded previously from Victoria.

I have received six nest series from Victorian collectors, one of which comprises an ovigerous queen which has been compared with an alate co-type. Associated with the queen were seven soldiers, eighteen large larvae, 3 young "second form" royalties and an adult de-alate male *Calotermes obscurus* Walker. The remaining colonies comprise soldiers, larvae and nymphae. In some colonies the soldiers vary considerably in size, but in each there are some which equal the co-types. The largest colony contains 10 soldiers and 190 larvae and nymphae.

Loc.—Victoria: Seaford (W. F. Hill), Ringwood (F. E. Wilson), Healesville (F. E. Wilson), Fern Tree Gully (F. P. Spry).

CALOTERMES (GLYPTOTERMES) NIGROLABRUM, n. sp. (*Figs.* 12-19.)

King. (Figs. 12-14.)

Colour: Head and pronotum chestnut, wing stumps darker, abdomen sandford brown, apex of abdomen, basal two-thirds of penultimate tergite and legs yellow ochre; labrum black; apex of clypeus white, membranous; antennae and mouth-parts sandford brown to chestnut; under surface yellow ochre, base of sternites buff yellow; tarsi brown.

Head (Fig. 12) slightly narrower than pronotum, widest across the eyes, rounded behind, surface finely shagreened, clothed with a few long and many minute setae. Labrum large, convex, slightly swollen on the sides, apex broadly truncate and fringed with fine setae. Clypeus more than three times wider than long, truncate in front, nearly straight behind. Eyes moderately large (0.282), nearly circular, projecting, finely faceted, lower margin 0.149 from lower margin of head. Ocelli broadly oval, oblique, in line with the middle of the eyes, from which they are separated by a distance equal to half their short diameter. Antennae (Fig. 13) ? 14-jointed, arising from a raised tubercle within a circular fossa in front of the middle of the eye, 1st joint short and broad at base, 2nd about half as long and much narrower, 3rd and 4th short, rounded, nearly as long as the following one, 6th, 7th and 8th narrow at the base, swollen at the apex.

Pronotum reniform, margin bent up, a deep depression behind the anterior margin on either side of the median line, margin with scanty fringe of short and long setae.

Wing stumps very dark in colour; those of forewings covering those of hindwings; the surface with scanty fine setae.

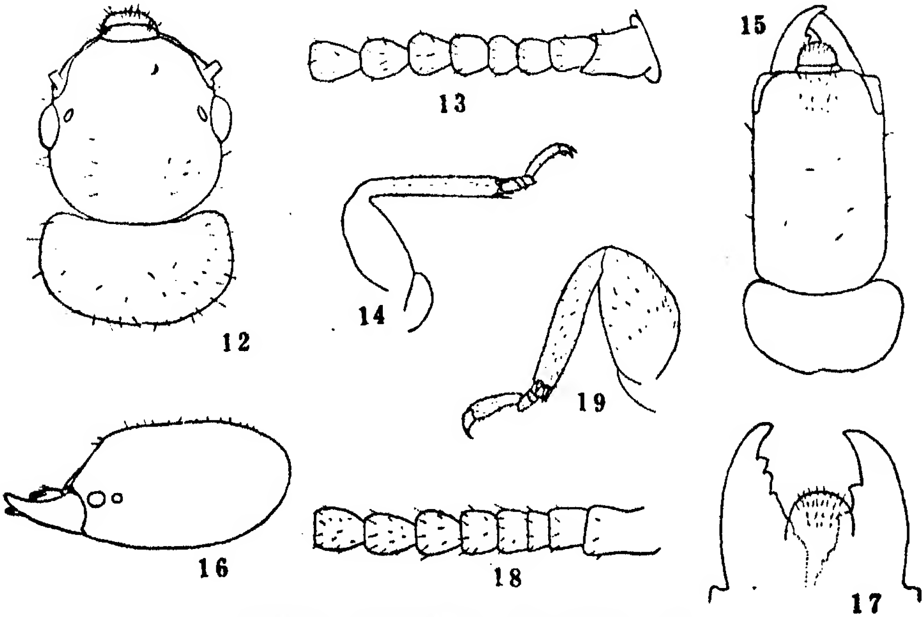
Legs (Fig. 14) moderately short and stout, clothed with fine, short setae. Tibial spines 3:3:3, serrate.

Abdomen elongate, nearly cylindrical, with apices of segments fringed with scanty, moderately long setae. Cerci short and stout.

Measurements:

Total length, 6.25.

Thorax and abdomen, long 5.00.
Head, from base to base of clypeus, long 1.128; from base to apex of labrum, long 1.316; at and including eyes, wide 1.222.
Pronotum, long 0.658; wide 1.269.
Tibia iii. 0.930.
Abdomen, wide 1.739.



Calotermes (Glyptotermes) nigrolabrum, n.sp.
Figs. 12-14. Imago. 12. Head and pronotum; 13. Antennae, proximal segments; 14. hind leg.
Figs. 15-19. Soldier. 15. Head and pronotum; 16. Head in profile; 17. Mandibles; 18. Antennae, proximal segments; 19. Hind leg.

Queen.

As above, excepting in size of abdomen, which is slightly longer and wider. In all of the examples of kings and queens available for study the antennae are mutilated, only eight to ten joints remaining. Nymphs of the first form have 14-jointed antennae, which is probably the maximum number in the imago.

Soldier. (Figs. 15-19.)

Colour: Head yellow ochre, turning to cinnamon rufous anteriorly; margin of antennal fossa and base of mandibles dark castaneous; mandibles black; antennae and pronotum cinnamon rufous; meso- and metanotum and tergites of abdomen yellow ochre; legs and sternites of abdomen a little paler.

Head (Figs. 15 and 16) long and narrow, rounded behind, parallel on the sides, curving in gradually from the antennal fossae to the base of the mandibles; an obscure, pale "Y" suture on forehead, from the fork of which the front

slopes to the base of the clypeus; clothed with a few moderately long, reddish setae. Eyes situated behind the base of the antennae, very small, pale coloured. Gula long and narrow, labrum short and broad (0.230 x 0.517) rounded in front. Clypeus broad and very narrow, anterior border slightly sinuate. Antennae (Fig. 18) 13-jointed, 1st joint short and wide, narrowest in the middle, 2nd about half as long, widest in the middle, 3rd short and wide, shortest of all, 4th and 5th short and wide, subequal, 6th narrow at base, widest beyond the middle. Mandibles (Fig. 17) 1.032 long, each with two teeth, those of the left mandible broad and blunt, those of the right more pointed.

Pronotum reniform, a little wider than head, clothed scantily with moderately large and small setae.

Legs (Fig. 19) short and stout, with scanty short, fine, setae. Tibial spines 3: 3: 3.

Abdomen long and narrow, segments with a scanty fringe of moderately long and short setae. Cerci moderately long (0.423). Styli present in males.

Measurements:

Total length (about) 9.00.

Head, from base to apex of clypeus, long 2.35; from base to apex of mandibles, long 3.15; wide 1.457; deep 1.316.

Pronotum, long 0.752; wide 1.595.

Meso- and metanotum, wide 1.692.

Antennae (13-jointed) 1.786.

Tibia iii. 0.940.

Abdomen, wide 1.598.

The soldiers vary somewhat in size, the above measurements being those of the majority. One example is only 5.25 long, with head and mandibles 2.440 in length, and 12-jointed antennae.

The nymphae (first form) in the type and other colonies are about 8.00 long and have 14-jointed antennae and unpigmented eyes. The wing rudiments are bright orange yellow.

Described from three colonies, taken in rotten logs on hill-side clad with tropical scrub (22nd June). The type colony comprised a king, queen, three soldiers and about 200 nymphae (first form) and larvae. Another comprised about 1000 larvae and nymphae, about 50 soldiers, three kings and three queens. Another comprised about 400 larvae and nymphae and 15 soldiers, but no imagos.

Affinities.—The imago appears to be most closely related to *Calotermes* (*Glyptotermes*) *trilineatus* Mjöb., from which it is distinguished, *inter alia*, by its lighter colour, dark wing stumps, smaller eyes and different head and pronotal measurements. From *Calotermes* (*Glyp.*) *brevicornis* Frogg. it is distinguished by its larger size (the former has a body length of 5.0 mm., as against 6.25 mm. in the new species), at least one more joint in the antennae and fewer tibial spines. The soldier castes of these two species differ considerably in size.

Loc.—North Queensland: Palm Island (G. F. Hill).

CALOTERMES (GLYPTOTERMES) (?) OBSCURUS Walker. (Figs. 20-29.)

Imago. (Figs. 20-25.)

Colour: Head and pronotum ochraceous orange, the latter suffused with brown; clypeus paler than head; legs and antennae tawny, suffused with brown; meso- and metanotum and wing-stumps very dark to blackish brown; dorsum of abdomen black, with the base of the first and the entire apical tergite brown; ventral surface brownish black, apex of abdomen, styli, and, in the male only,

the middle of sternites one to four, paler; wings very dark, nearly as dark as sternites of abdomen, veins darker.

Head (Figs. 20 and 21) small, round, convex on the summit, with very few setae. Labrum small, slightly swollen on the sides, bluntly rounded in front. Anteclypeus large, three-tenths as long as wide, membranous. Eyes small (0.188 x 0.235), not prominent, finely faceted, lower margin distant 0.188 from lower margin of head. Ocelli small, oval, well separated from, and in

20 21 22

Calotermes (Glyptotermes)? *obscurus* Walker.

Figs. 20-22. Imago. 20. Head; 21. Head in profile; 22. Pronotum.

line with the middle of, the eyes. Antennae 13- (rarely 14-) jointed, the first joint short and stout, 2nd half as long and three fourths as wide as 1st, 3rd nearly as long as 2nd but wider at apex, 4th very little shorter than 3rd, shortest of all, rounded, 5th-12th increasing in length and width, 13th shorter or about as long as 12th, broadly oval.

Thorax: Pronotum (Fig. 22) large, wider than head, wider than long, anterior margin convex, sides rounded, postero-lateral angles nearly straight, posterior margin markedly sinuate, clothed sparsely with short, fine, pale setae, a deep depression behind the anterior margin on either side of the median line. Meso- and metanotum with dark median line on anterior two-thirds, posterior margin slightly sinuate.

Wings: Wing-stumps of forewings more than twice as long as those of hindwings, extending posteriorly to the apex of the metanotum, with a few minute setae. Wings (Fig. 23, Pl. xxxvi.) nearly equal in length and width and bearing a few minute setae along the main veins; the membrane (Fig. 24, Pl. xxxvi.) is without setae, but, like the veins, it is covered with small scale-like spots, densest on the veins, but present in more or less irregular lines between them. In the forewing the subcosta is short, about one-fifth the length of the wing; the radius is about twice as long as the subcosta and bears a superior branch about the middle; the radial sector has about ten superior branches, the media is nearly parallel to the radial sector, joins the costal margin at the apex of the wing, bears about 3 inferior branches towards its distal end and several short, indistinct, superior branches to the radial sector; the cubitus traverses the middle of the wing and bears about 12 simple or forked branches to the posterior margin. In the hindwing the subcosta is wanting; the radius bears three short, superior branches, the radial sector seven or eight; the media branches from the radial sector well beyond the suture, not at the base of the wing stump as in the forewing.

Legs (Fig. 25) short and moderately stout. Tibial spines 3: 3: 3, serrate.

Abdomen nearly parallel on the sides, flattened dorso-ventrally, bluntly

pointed in the male, more rounded in the female, segments with scanty, fine, short setae. Styli (male) long and slender. Cerci short and very stout.

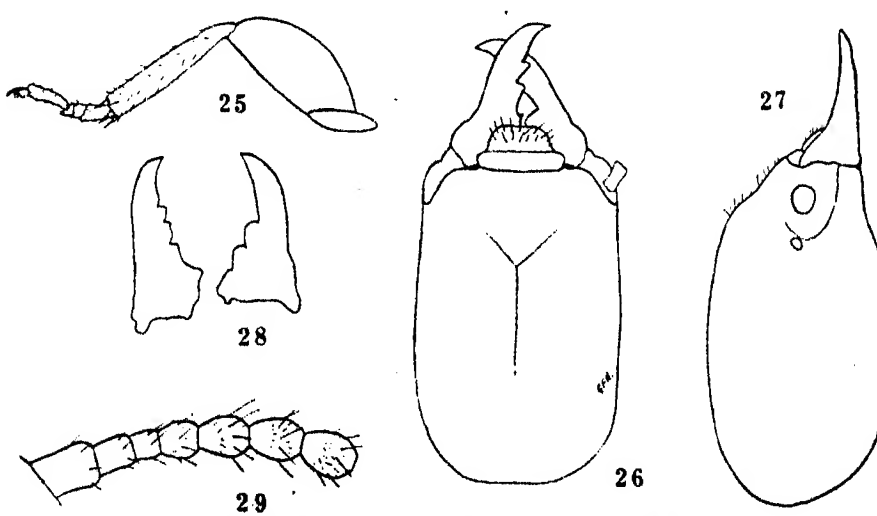
Measurements:

Length, with wings 9.0-9.5; without wings 4.5.
Head, from base to base of clypeus, long 1.081; from base to apex of labrum, long 1.410; at and including eyes, wide 1.128; deep 0.705.
Antennae (13- or 14-jointed) long 1.786.
Pronotum, long 0.752; wide 1.222.
Wings: forewings, long 7.0-7.25, wide 2.491; hindwings, long 6.75-7.0, wide 2.585.
Tibia iii. 0.940.
Abdomen, wide 1.222.

Soldier. (Figs. 26-29.)

Colour: Head ochraceous orange, darker anteriorly; labrum and antennae same colour as posterior part of head; legs and ventral surface yellow ochre.

Head (Figs. 26 and 27) long and narrow, less than half as wide as long (with jaws), nearly straight on the sides to the antennal fossae, rounded behind; front slightly rugose, sloping gently to the base of the clypeus, which is short, wide and nearly straight in front; dorsal surface in profile slightly convex, clothed with a few small setae; "Y" suture composed of fine but very distinct lines. Labrum very short and broad, bluntly rounded in front. Mandibles (Fig. 28) short and very stout, with three stout teeth on the left and two on the right, all of the former and one of the latter projecting beyond the apex of the labrum. Eyes small, oval, whitish, adjacent to posterior margin of antennal fossae, the latter being a wide and shallow depression. Antennae (Fig.



Calotermes (Glyptotermes) ? obscurus Walker.
Fig. 25. Imago, hind leg.
Figs. 26-29. Soldier. 26. Head; 27. Head in profile; 28. Mandibles; 29. Antennae, proximal segments.

29) (12) 14-jointed, 1st joint short and stout, 2nd quadrate, about two-thirds the length of 1st, 3rd very short and narrow, smallest of all, 4th as long but wider than 2nd, rounded, 5th to 11th increasing in length, 12th shorter and narrower than 11th. Gula long and narrow in the middle, where it is one-fifth the width of the head.

Thorax: Pronotum as in imago, very little narrower than head, margin narrowly bordered with ferrugineous. Meso- and metanotum with posterior margin slightly sinuate. In some individuals there is evident development of wing rudiments; in some these are hardly recognisable, in others they are as long as in nymphae of the first form.

Legs short and stout, with scanty setae, femora thickened. Tibial spines 3: 3: 3, serrate.

Abdomen nearly parallel on the sides, bluntly-pointed at the apex, segments with scanty fringe of fine setae. Cerci short and stout. Styli long and slender.

Measurements:

Total length 6.50.
Head, with jaws, long 2.820; base to apex of clypeus, long 2.162; wide 1.222; deep 1.081.
Mandibles, long 0.950.
Antennae (12-jointed) 1.222.
Pronotum, long 0.752; wide 1.130.
Abdomen, wide 1.081.

Identification.—I am in considerable doubt as to the identification of this species, and for this reason a full description is given of the alate and soldier castes. Dr. G. A. K. Marshall, to whom alate forms were submitted, kindly compared them with the damaged types of *Calotermes obscurus* Walker and *C. convexus* Walker. After referring to the differences between Walker's two species, Dr. Marshall suggested that I should provisionally regard my specimens as being referable to the first-mentioned. Hagen (1858) and Desneux (1904) place *C. obscurus* as a synonym of *C. convexus*. Froggatt (1906) quotes Hagen's description of *C. convexus*, which does not agree with the species before me, especially in the shape of the pronotum. In the description quoted by Froggatt and in Dr. Marshall's notes respectively the posterior margin of the pronotum is stated to be *"flattened"* or *"nearly straight."* In my specimens the pronotum is markedly sinuous posteriorly, as noted by Dr. Marshall in the type of *C. obscurus*. Holmgren (1911) refers *C. convexus* doubtfully to the subgenus *Cryptotermes*.

Mjöberg (1920) omits both of Walker's species from his list of Australian species, presumably as being amongst those which have been too incompletely described to be identified.

From the available information it would appear that *C. obscurus* (from Western Australia) is not conspecific with *C. convexus* (from Tasmania), as has been supposed. Whether the Victorian specimens here described are conspecific or not with the former can, in view of the damaged condition of the type, only be settled by the examination of a series of alate forms from the type locality (Swan River, W.A.), where Mr. J. Clark has, during the past two years, made a very thorough survey of the termite fauna. So far no alate forms have been discovered, but soldiers and nymphae recently collected by him may be conspecific, the only apparent difference being a slightly rugose front in the former caste. In view, however, of the slight difference in the soldiers of distinct species, this difference may well be specific. Froggatt further quotes

Hagen as stating that *C. convexus* closely resembles *C. improbus* Hagen from Tasmania , but from the description of the latter, as quoted by Froggatt, it is evidently quite distinct from the species now described by me as *C. convexus* Walker. Unfortunately very little is known of the termite fauna of Tasmania and until recently only three species have been recorded from that island. Of these *Stolotermes brunneicornis* Hagen is known only from three alate imagos, and *Calotermes improbus* Hagen only from a de-alate and damaged imago. A recently described species, *Porotermes froggatti* Holmgren, is unknown to me.

Biology: Of the nine colonies taken by Mr. W. Hill, eight were found in the "Mallee"-like roots, trunks or branches of living or dead Eucalypts, and one in a verandah post, in association with a species of *Leucotermes*. In three cases a few soldiers and nymphae of *Porotermes adamsoni* (Froggatt) were found in the colony. *C. obscurus* has also been taken in colonies of *Porotermes adamsoni* in the same locality. Generally only a few soldiers and nymphae of the former were present, but in one instance a king only was found, apparently as consort of the gravid queen of the host species. Winged imagos were captured in January, June and July, at Seaford, and in March, at Beaconsfield. The Lakes Entrance specimens were found in a Eucalyptus stump, in association with soldiers and workers of *Eutermes fumigatus* Brauer, or a very closely allied species. The Western Australian specimens, which I have provisionally referred to *C. obscurus*, were found in a rotten Banksia stump, with numerous soldiers, workers and larvae of *Leucotermes clarki* Hill.

In all cases the colonies were small, the largest comprising the soldiers and 300 larvae and nymphae. When alate forms were present they numbered less than thirty individuals.

Loc.—Victoria: Seaford (W. F. Hill), Beaconsfield (F. E. Wilson), Lakes Entrance (F. E. Wilson); (?) S.W. Australia: Swan River (J. Clark).

CALOTERMES (GLYPTOTERMES) TRILINEATUS Mjöb.

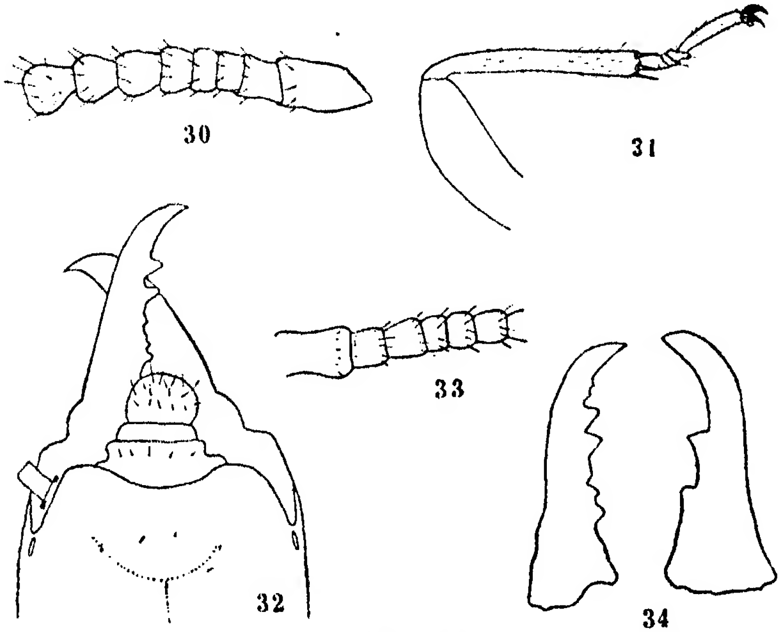
Arkiv för Zoologi, Vol. 12, No. 15, 1920.

Imago. (Figs. 30 and 31.)

Colour: Dorsal surface castaneous, abdomen lighter than head and thorax; under surface of thorax, legs, mouth-parts, antennae, first and middle of second and third sternites brussels brown, remainder of sternites darker but rather lighter than tergites; wings iridescent, anterior veins and eight proximal branches of cubitus dark brown, membrane between the latter suffused with brown.

Head narrower than prothorax, rounded behind and on the sides to the posterior margin of the eyes, the surface finely shagreened, clothed with numerous minute and a few larger setae. Labrum dark, with scattered pale setae, slightly swollen on the sides to the broadly truncate apex. Clypeus pale, anterior margin membranous, three times wider than long, sides rounded to the truncate apex, a group of three setae near each postero-lateral angle. Antennae (Fig. 30) 14-jointed, arising from a raised tubercle within a depression in front of the middle of the eye, 1st joint short and not greatly widened, curved on the sides, 2nd about half as long and a little narrower, 3rd joint shortest and narrowest or as long but narrower than 4th, or rarely longer than 4th, 5th longer and wider than 4th, 6th-13th increasing in length, 14th about as long but narrower than 13th, elongate-oval. Eyes very large and prominent, measuring vertically 0.329, horizontally 0.376, finely faceted, lower margin 0.188 from lower margin of head. Ocelli rather large, broadly oval, oblique, close to, and in line with, the middle of the eye.

Thorax: Pronotum reniform, margin slightly bent up, more so anteriorly, a deep depression behind the anterior margin on either side of the middle line, posterior margin not emarginate, entire margin with a scanty fringe of long



Figs. 30, 31. *Calotermes (Glyptotermes) trilineatus* Mjöb. Imago.
30. Antennae, proximal segments; 31. Hind leg.
Figs. 32-34. *Calotermes (Neotermes) insularis* White. Soldier.
32. Head; 33. Antennae, proximal segments; 34. Mandibles.

and short setae, fewer and shorter in front, and remainder of surface. Meso- and metanotum markedly sinuate posteriorly, similarly clothed.

Wings: Wing-stumps with a few pale setae, base of veins very distinct, cross-suture convex, anterior pair much larger than posterior, the former almost covering the latter. Wings slender, forewings a little longer and narrower than hindwings, costal margin with scanty fringe of setae, veins with scale-like appearance, membrane with minute scale-like spots, subcosta of the forewing very short, joining the costa just beyond the suture; radius about five times longer; radial sector unbranched, joining the costa before the apex; media very distinct, like the preceding, running close to the radial sector and joining the costa at or very near the apex; cubitus traversing the middle of the wing, with about 13 inferior branches, the first four distinct, the next four very indistinct at their proximal end, the remainder indicated by rows of scale-like spots similar to those scattered over the membrane. In the hindwing the media branches from the radial sector well beyond the suture (about 1 mm.)

Legs (Fig. 31) moderately short and stout, clothed with short fine setae, femora thickened. Tibial spines 3: 3: 3, serrate.

Abdomen nearly cylindrical, bluntly rounded posteriorly, apices of the tergites fringed with short, pale setae. Cerci short (0.450) and stout.

***Measurements*:**

Length with wings 11.0-11.50; without wings 6.25.
Thorax and abdomen, long 4.75.
Head, from base to posterior margin of clypeus, long 1.175; at and including eyes, wide 1.410; deep 0.800.
Antennae 1.880.
Pronotum, long 0.800; wide 1.363.
Wings: forewing, long 8.50, wide 2.068; hindwing, long 8.00-8.25, wide 2.256. Tibia iii. 1.270.
Abdomen, wide 1.500.

King and Queen.

Similar to the above, but slightly darker. Both have the antennae mutilated, ten or eleven joints only remaining. The abdomen of the latter is about 1 mm. longer and a little wider than that of the alate form.

Biology: The king and queen described above were taken in a rotten log lying in dense tropical forest in the type locality. With them were found young larvae, nymphae of the first form, and soldiers, numbering in all several thousand individuals, of which soldiers comprised about 1 per cent. There were no eggs or very young larvae in the colony.

A portion of the log, containing soldiers and nymphae of the first form, was placed in a jar and kept moist from date of capture on 22nd May until 2nd August following, when the alate forms, here described, emerged.

Identification: By comparison of soldiers and nymphae with co-types of these castes.

Loc.—N. Queensland: Malanda (G. F. Hill).

CALOTERMES (GLYPTOTERMES) AFFINIS Mjöb.

Arkiv för Zoologi, Vol. 12, No. 15, 1920.

The above name appears to be preoccupied, having been used by Hagen for a fossil species from Prussian Amber (Hag. Linn. p. 53).

CALOTERMES (NEOTERMES) INSULARIS White.

Soldier. (Figs. 32-34.)

Colour: Head orange rufous, mandibles black, labrum and antennae tawny, third joint of latter much darker, remainder of insect buff yellow.

Head (Fig. 32) very long, broadly rounded behind, curved on the sides, widest across the middle and sloping in to the base of the mandibles; front slightly rugose, sloping to the base of the clypeus. "Y" suture distinct. Labrum small, rounded. Clypeus moderately large; anteclypeus membranous, truncate in front. Antennae (Fig. 33) 17-jointed, 1st joint very large, twice as long as 2nd, narrowed in the middle, swollen at the apex, 2nd nearly quadrate, these two joints paler than others, 3rd as long and wide at the apex as 2nd, narrower at base, 4th smallest of all, 5th a little longer and wider than 4th, 6th-16th increasing successively in length and decreasing in width at the base, 17th much shorter than 16th, oval. Gula long and narrow, about one-ninth as wide as head. Mandibles (Fig. 34).

Thorax: Pronotum very large, much wider than long, not quite as wide as head, anterior margin slightly concave and bent up, sides rounded, posterior margin slightly concave, margin all round darker than rest of surface, darkest

in front, with scanty reddish, stout setae. Meso- and metanotum with margin darkest, much narrower than pronotum.

Legs short and stout, clothed with scanty, red setae. Tibial spines 3: 3: 3.

Abdomen narrow, elongate, flattened dorso-ventrally, traversed by a dark median line which passes anteriorly to the middle of the pronotum, tergites and sternites with scanty reddish setae. Cerci short and stout, apparently 2-jointed. Styli long and slender.

Measurements:

Total length 14.75.
Thorax and abdomen, long 7.75.
Head and mandibles, long 7.00.
Head, base to anterior margin of clypeus, long 4.25; deep 2.58; wide 3.80.
Antennae (17-jointed) 3.19.
Pronotum, long 1.74; wide 3.48.
Meso- and metanotum, wide 2.60.
Tibia iii. 2.30.
Abdomen, wide 2.96.

Described from a small colony, comprising two alate imagos, six soldiers, 40 nymphae, about twenty larvae and two neoteinic queens, taken in a hollow Eucalyptus stump, in January. This appears to be a rare species, known hitherto only in the alate form. It is recorded from New Zealand.

Loc.—Victoria: Seaford (W. F. Hill), Melton (F. P. Spry).

CALOTERMES (CRYPTOTERMES) PRIMUS, n. sp. (Figs. 35-40.)

Imago. (Figs. 35-37.)

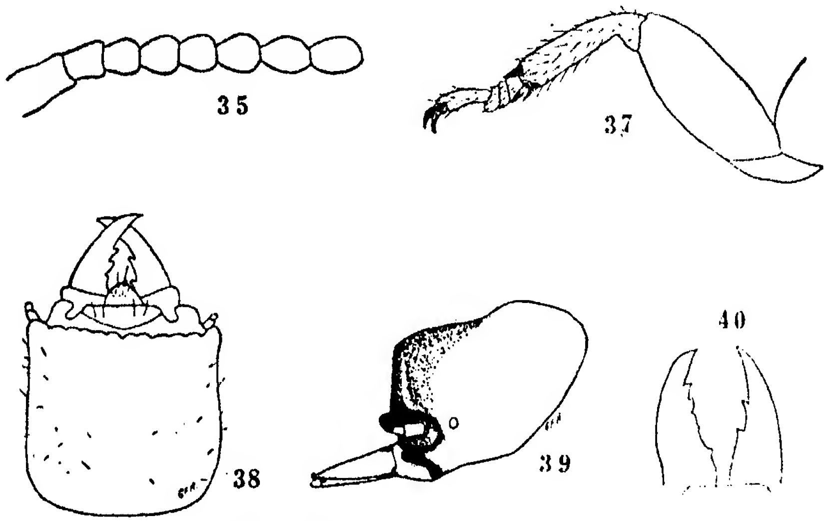
Colour: Ochraceous-tawny above, yellow ochre below; wings iridescent, anterior veins buckthorn brown.

Head small, longer than wide, rounded behind, the whole surface minutely shagreened and bearing scattered setae. Eyes very large (0.329 x 0.282) and prominent, coarsely faceted, lower margin half the vertical diameter from lower margin of head. Ocelli large, contiguous to inner margin of eye. Clypeus rather less than half as long as wide, anterior margin concave, posterior margin convex. Labrum rather large, markedly convex and swollen on the sides, rounded in front. Left mandible with a large, sharp tooth at the apex, followed by a much smaller pointed one and a short, wide, cutting edge; right mandible with the two apical teeth as in left and a very much wider cutting edge towards the inner side. Antennae (Fig. 35) long, 16- (rarely 17-) jointed, springing from a circular cleft in front of the eye, 1st joint short, stout and slightly narrowed at the apex, 2nd three-fourths as long and nearly as wide at apex as 1st, 3rd, 4th and 5th equal, or 3rd shorter and narrower than 4th and 5th or, rarely, 3rd longer than 4th and 5th, as long as 2nd, 6th-15th increasing in length successively, 16th a little shorter and narrower than 15th, oval.

Pronotum much wider than long, concave in front, rounded on the sides to the rounded and slightly sinuate posterior, anterior margin and sides a little bent up and fringed with a few pale setae.

Wings (Fig. 36, Pl. xxxvi.) equal, rather less than four times as long as wide; a few minute setae on costal margin as far as junction of last branch of radial sector, and a few on radius and radial sector; under high power the principal veins have a scaly appearance. In the forewing the subcosta joins the costa just beyond the cross suture; the radius also is short and joins the costa a little before the middle of the wing; the radial sector has seven or eight

superior branches, all of which join the costa before the apex of the wing, and sometimes a few indistinct inferior branches near the apex; the media branches within the wing stump, traverses the wing just above the middle and nearer to the cubitus than to the radial sector, has three or four branches, the second of which generally joins the radial sector towards the apex of the wing, where it is thickened; the cubitus is indistinct and has about 12 branches, some of which



Calotermes (Cryptotermes) primus, n.sp.
Figs. 35, 37. Imago. 35. Antennae, proximal segments; 37. Fore leg.
Figs. 38-40. Soldier. 38. Head; 39. Head in profile; 40. Mandibles.

terminate just below the apex of the wing. In the hindwing the subcosta is wanting and the media branches well beyond the cross suture. The wing-stumps of the forewing are very much larger than those of the hindwing, which they nearly cover, the surface bears a few minute setae and the cross suture is convex.

Legs (Fig. 37) short and moderately stout, tibiae slightly widened at apex and moderately setaceous; 1st tarsal as long as 2nd and 3rd together. Tibial spines 3: 3: 3, serrate.

Abdomen elongate, slightly widened beyond the middle, bluntly rounded at apex, segments with scanty fine setae. Cerci short and very stout at base.

Measurements:

Length with wings 9.50; without wings 4.50.

Head, base to apex of labrum, long 1.128; at and including eyes, wide 0.987.

Antennae 2.162.

Pronotum, long 0.517; wide 0.940.

Wings, long 7.50; wide 2.25.

Tibia iii. 0.940.

Abdomen, wide 1.410.

Soldier. (Figs. 38-40.)

Colour: Mandibles, clypeus and anterior half of head black, posterior half hazel.

Head (Figs. 38 and 39) very short, wide and deep, sides widening slightly to a prominence above the insertion of the antennae, abruptly truncate anteriorly, the upper margin sinuate and overhanging the deeply excavated front, anterior of dorsal surface of head rugose, the whole surface finely shagreened, a large, black tubercle on either side projecting forward from the front mesad of the antennal fossa. Clypeus indistinct, moderately large, anterior margin membranous. Labrum about twice as long as wide, rounded on the sides to the bluntly pointed apex, where there are two long and several short setae. Antennae 13-jointed, short and stout, 1st joint about twice as long and a little wider than 2nd, widest at apex; 2nd curved, a little widened at apex, 3rd about half as long as 2nd and narrower; 4th half as long as 3rd and about as wide, smallest; 5th-11th rounded, increasing in length and becoming more stalked progressively; 12th a little longer and narrower than 11th; 13th shorter and narrower than 12th, oval. Eyes small, oblique, oval, indistinct. Mandibles (Fig. 40) short and stout, with two teeth on each side, those on the right being further from the apex and more acute than those on the left.

Pronotum wider than long and overlapping the base of the head, bent down at the sides, anterior margin deeply concave in the middle, sinuate towards the sides, sides a little rounded and sloping to the sinuate posterior margin, clothed with a few setae, median suture distinct, a deep depression on either side behind the anterior margin. Meso- and metanotum about as wide as pronotum, posterior margin nearly straight.

Legs short and stout; femora thickened; tibiae nearly cylindrical; claws short and stout, empodium small. Tibial spines 3: 3: 3, serrate.

Abdomen long and narrow, wide at base, bluntly rounded at apex; segments with a scanty fringe of setae. Cerci very short and stout at base.

Measurements:

Total length 4.50-5.00.

Head, to apex of mandibles, long 1.645; from base to anterior margin of truncate front, long 1.128; wide 1.175; deep 0.940.

Thorax and abdomen, long 3.290.

Pronotum, long 0.893; wide 0.175.

Tibia iii. 0.800.

Abdomen, wide 1.175.

Biology: On 12th May, 1919, a colony of these termites was found in one of several pieces of imported soft wood (portion of a dismantled chicken coop) lying upon the ground. The wood was free from all traces of decay and was quite sound excepting for the damage done by the insects. The forms found in the passages comprised about 1 dozen soldiers, 80 alate adults and as many nymphae. Twenty days later another piece of wood from the same source and position was examined and found to contain numerous eggs, a mature king and queen, about 30 soldiers and many nymphs, but no alate forms. The queen was in a gallery not differentiated from those occupied by the other forms and the eggs were scattered throughout all parts of the infested wood. A few soldiers and nymphae were taken on subsequent dates but no more alate forms were found in the remaining pieces of wood, although several were captured between 7.30 and 8.30 p.m. at a lamp in the house close by, i.e., one each on 2nd and 3rd June, 2 each on 8th and 20th June. No further observations were made in this vicinity, but at my present residence, about ¾ mile distant, I took one winged form at a lamp on each of the following nights, i.e., 20th Aug. 1919, 6/8/20, 18/9/20, 18/10/20, 12/3/21, 13/3/21, 27/3/21, 28/3/21, 29/3/21, 17/7/21, 27/7/21.

On 2nd July, 1920, a young king and queen, with one egg, were found in a weevil hole (*Euthyrrhinus meditabundus*) in a dead mango branch. The egg lay on the floor of the hole about one inch from the entrance, which was tightly plugged with comminuted wood. On two subsequent occasions, two pairs (4th July) and one pair (12th Nov.) were found in similar positions in the same tree, but in these cases no egg was present, indicating that the termites had only recently entered the holes from which the weevils had emerged. From May to August the weather in Townsville is dry and generally chilly at night.

From the facts recorded above it is evident that the alate imagos of this species do not leave the parent colony in a "colonising" flight at any definite season of the year but in small numbers throughout a prolonged period of the year.

It is to be noted, also, that no alate forms have been captured during the months of high temperature and greatest rainfall, as is the case in many other species. It would appear, also, that new colonies are generally founded by alate pairs, as is, I think, the case with most Australian species.

Loc.—N. Queensland: Townsville.

Subfamily **RHINOTERMITINAE** Frogg.

Genus PARRHINOTERMES Holmgr.

PARRHINOTERMES AUSTRALICUS Mjöb.

Arkiv för Zoologi, Vol. 12, No. 15, 1920.

This species was described by Mjöberg under the name *Parrhinotermes queenslandicus* and is referred to again on p. 126 under that name, but on pages 109 and 124 it is referred to as above, which would appear to be correct, since co-type specimens kindly presented to me by Professor Sjostedt are so labelled.

I have taken this species in the type locality (Malanda, N.Q., May, 1921) in a rotten log and in the vegetable debris beneath it. The colony comprised workers, soldiers, larvae and nymphae showing first appearance of wing buds, presumably from a nest situated in the soil in the vicinity. In their habits they appear to resemble very closely an undescribed species of *Rhinotermes*, which was taken in the same log and in others in the vicinity.

Genus RHINOTERMES Hagen.

RHINOTERMES (SCHEDORHINOTERMES) BREINLI, n. sp. (Figs. 41-50.)

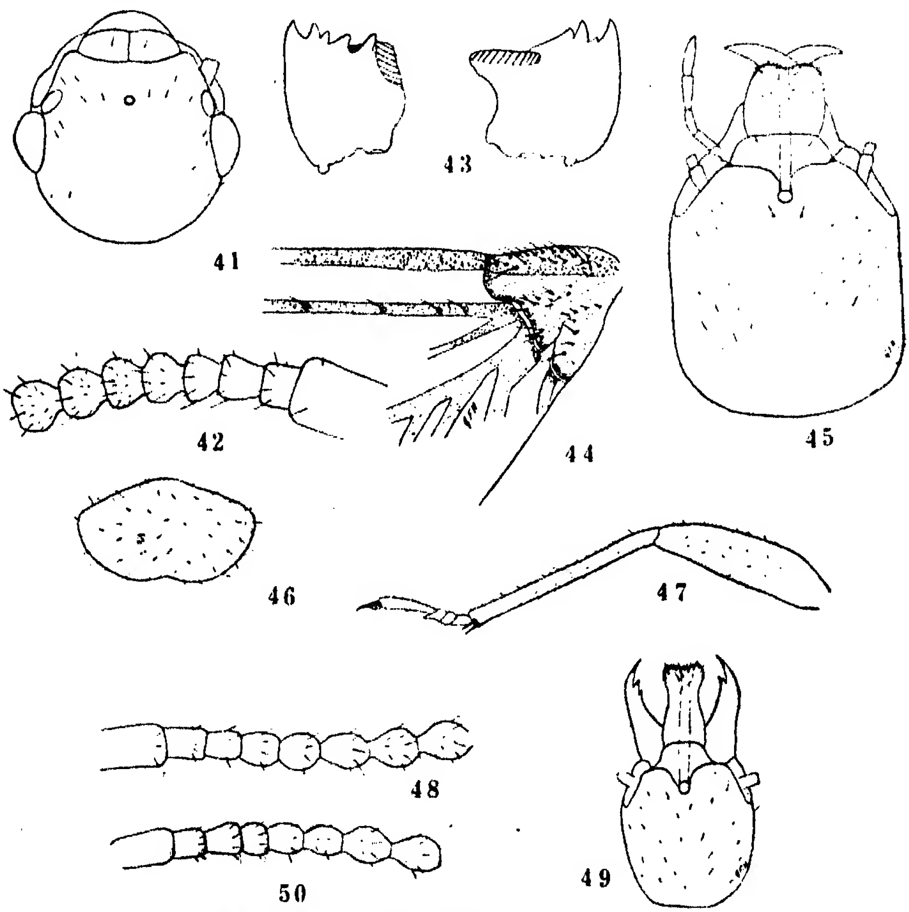
Imago. (Figs. 41-44.)

Colour: Ochraceous tawny above, yellow ochre below, wings hyaline, with costal margin yellow ochre.

Head (Fig. 41) small, rounded behind and on the sides, flattened dorso-ventrally, middle of dorsal surface depressed and faintly rugose about the fontanelle, scantily pilose. Labrum slightly convex, narrow at the base, widening on the sides to the width of the clypeus, with few reddish setae. Anteclypeus membranous, two-thirds as long as postclypeus, lobed in the middle. Postclypeus convex, divided medially by a ferrugineous suture, a little wider than long, slightly arcuate behind, truncate in front, with a few reddish setae. Eyes very large and prominent, nearly circular (.399 x .446). Ocelli large, broadly oval, separated from the eyes by a distance equal to one-third their long diameter. Fontanelle large, circular. Mandibles (Fig. 43) with four pointed teeth on left, two on the right, the latter separated by a small angular tooth. Antennae (Fig.

42) 20-jointed, 1st joint short quadrate, nearly as wide as long, 2nd quadrate, half as long as first, as wide as long, 3rd a little longer and wider than 2nd, turbinate, 4th and 5th subequal, shorter and narrower than 3rd, slightly turbinate, 6th and 7th subequal, similar to, but larger than 4th and 5th, 7th-20th moniliform.

Pronotum narrower than head, truncate and slightly bent up in front, sides rounded, posterior margin bilobed, outer margin fringed with moderately long reddish setae.



Rhinotermes (Schedorhinotermes) breinli, n.sp.

Figs. 41-44. Imago. 41. Head; 42. Antennae, proximal segments; 43. Mandibles; 44. Base of hindwing.

Fig. 45-50. Soldier. 45. Head of large form; 46. Pronotum of large form; 47. Hind leg of large form; 48. Antennae of large form, proximal segments; 49. Head of small form; 50. Antennae of small form, proximal segments.

Wings: Wing-stumps (Fig. 44) large, moderately setaceous, anterior pair (1.03 long) twice as long as posterior pair. The first and second veins of fore- and hindwings well separated to their junctions near apex of wing, the remain-

ing veins very indistinct and irregularly branched; 2nd vein with a few setae along its entire length, remaining veins and membrane without setae or sculpture.

Legs moderately short and slender, femora a little thickened, with scattered reddish setae. Tibial spines 3: 3: 2, long and slender.

Abdomen short, broad, rounded at the apex, apical half of tergites and sternites with very scanty setae, pleurites densely setaceous. Cerci short and stout. Styli present in male only.

Measurements:

Length with wings 11.0-11.5; without wings 7.0.

Head, from base to base of clypeus, long 1.03; at and including eyes, wide 1.41; deep 0.80.

Antennae (20-jointed) 2.50.

Pronotum, long 0.75; wide 1.18.

Wings: forewings, long 9.00, wide 2.85; hindwings, long 8.75, wide 3.00.

Tibia iii. 1.05.

Abdomen, wide 1.64.

Soldier (Large form). (Figs. 45-48.)

Colour: Yellow ochre above, antennae, legs and under surface slightly paler, clypeus hazel, mandibles ferrugineous.

Head (Fig. 45) large, quadrate, broadly rounded behind, sides widening a little to the posterior margin of the antennal fossae, then drawing in to the base of the mandibles, with scanty, stout, reddish setae. Labrum large, about twice as long as clypeus, covering apical teeth of mandibles, slightly swollen on the sides, deeply emarginate in front. Clypeus large, divided medially by a deep furrow which passes forward from the fontanelle to the apex of the labrum. Fontanelle large. Mandibles very stout with two apical teeth on the left, one on the right. Antennae (Fig. 48) 17- or 18-jointed, 3rd joint shortest but very little shorter than 4th and 5th, 5th to 17th moniliform, 18th small, broadly oval.

Pronotum (Fig. 46) wider than head, flat, with margin bent up, convex in front, sides sloping to the concave posterior margin, clothed with scanty short, stout, red setae. Meso- and metanotum wider than pronotum and similarly clothed.

Legs (Fig. 47) rather slender. Tibial spines 3: 2: 2.

Abdomen broad and flattened, widest in the middle, broad at base, bluntly rounded at the apex, segments with scanty setae. Cerci large, broad at base, conical at apex. Styli present.

Measurements:

Total length 5.5.

Thorax and abdomen, long 3.10.

Head, base to apex of labrum, long 2.20; wide 1.55; deep 0.89.

Antennae (17- or 18-jointed) 1.92.

Mandibles, long 1.03.

Pronotum, long 0.66; wide 1.18.

Tibia iii. 1.27.

Abdomen, wide 1.31.

Soldier (Small form). (Figs. 49 and 50.)

Colour: Yellow ochre, clypeus ochraceous tawny, mandibles light ferrugineous.

Head (Fig. 49) small, widest behind the antennal fossae, narrower posteriorly, broadly rounded behind, clothed as in large form. Labrum long and

slender, scantily setaceous at apex. Clypeus broad, nearly truncate in front. Antennae (Fig. 50) 16-jointed, 4th joint shortest, 5th-13th moniliform, 14th and 15th turbinate, 16th small, broadly oval. Mandibles large with dentition as in large form.

Pronotum of the same form as large form.

Legs as above, but tibia more thickened.

Abdomen: Styli present.

Measurements:

Total length 3.00.
Thorax and abdomen, long 2.58.
Head, base to apex of labrum, long 1.55; wide 0.820; deep 0.517.
Antennae (16-jointed) 1.70.
Mandibles, long 0.658.
Tibia iii. 0.893.
Abdomen, wide 0.893.

Worker.

Colour: Cream, with ferrugineous spot at postero-lateral angle of clypeus.

Head large, rounded behind and on the sides, flattened above, clothed with scattered setae. Labrum large, convex, swollen on the sides, rounded in front. Clypeus large, truncate in front, convex behind, divided medially by a distinct suture. Antennae 17- or 18-jointed, 3rd joint much longer than 2nd, 4th shortest of all. Mandibles with dentition as in imago.

Measurements:

Total length 5.50.
Head, base to apex of labrum, long 1.410.
Antennae 1.880.

Affinities: Two species, *R. reticulatus* Froggatt and *R. intermedius* Brauer, from Australia have been described previously. The imago of the new species may be distinguished from the former by its darker colour, narrower head, much larger and more projecting eyes, much larger ocelli, narrow pronotum and greater space between ocelli and eyes.

	R. breinli, n.sp.	*R. reticulatus* Frogg.*
Length with wings	11.0	11.0
Width of head	1.410	1.504
Width of pronotum	1.175	1.265
Diameter of eyes	0.376 x 0.423	0.282 x 0.329

The soldiers of these two species are very similar, but those of *R. breinli* have darker heads and darker and stouter setae on head, thorax and abdomen.

From imagos collected by me in Northern Territory and identified by Mr. Froggatt as *R. intermedius* Brauer, and from others from Mt. Tambourine, Queensland, collected and similarly identified by Dr. Mjöberg, *R. breinli* is distinguished, *inter alia*, by its smaller size and smaller eyes; these two, however, are not conspecific, Dr. Mjöberg's specimens being considerably larger and more robust, and having larger eyes than those from the Northern Territory. Unfortunately, I have not had for comparison the soldier castes from the same nest series as the imagos in the case of Brauer's species (as identified by Froggatt), but I have compared both forms of soldiers of *R. breinli* with specimens from Mackay, Q., from Mr. Froggatt's collection, and find them to differ markedly in the colour and shape of the head.

*Measurements and other particulars are from co-types from Kalgoorlie, W. Australia.

The nearest ally of *R. breinli* appears to be a rather larger species from Magnetic Island, Q. Of this species I have at present only a young king and queen, taken under a log (10th Feb.), and several series of soldiers and workers from logs and trees in the vicinity, which may be conspecific, but the material is insufficient to describe as a new species in such a difficult genus. For the same reason I have withheld descriptions of a very distinct species from Malanda, Atherton District, N.Q., and other apparently distinct species. I can find no differences between my new species and an imago from Kimberley, N.W.A., collected and identified by Dr. Mjöberg as *R. reticulatus* Froggatt.

Biology: This is one of the common species of termite found in the Townsville district, where it causes very considerable damage to wooden houses and fences and probably ranks next to *Mastotermes darwiniensis* in economic importance. It is met with frequently in bush localities, under and within fallen logs, in tree trunks and under the generally fragile clayey covering with which it encases dead trees and fence posts. The trunks of *Pandanus* sp. are very often attacked and completely destroyed; house-blocks are occasionally attacked and large numbers of soldiers and workers have been found in the earthen termitaria of *Hamitermes perplexus* Hill.

On several occasions the wooden portion of the Australian Institute of Tropical Medicine has been attacked, and on one occasion some damaged timber had to be replaced as a result of infestation by these insects. This building was constructed on a plan quite unsuited to the requirements of a termite-infested locality, the main uprights (Australian hardwood) passing through the concrete floor into the soil below, thus affording an easy means of access to the softwood plates and lining boards.

Hardwood fencing is often badly damaged by these termites, but as the infested portions are nearly always encased in a protecting layer of earthy matter their presence is easily detected and remedial measures can be taken.

Nothing is known concerning the origin of new colonies of this or any other Australian *Rhinotermes*, but it is surmised that they are founded late in summer by a pair of imagos from the parent colony, as is known to be the case in two undescribed species, young kings and queens of which have been found in pairs under logs, subsequent to fertilization of the females, but prior to oviposition. There is a good deal of evidence to support the belief that all the imagos (winged adults) do not leave the parent colony together in one "colonising" flight, as do many species, but that "swarming" takes place over a period of some months.

Mature first form (true) kings and queens and neoteinic kings and queens are not known in Australian species of this genus, nor is there any record of the discovery of a nest. In a previous paper (Hill, 1915) I have recorded having found a mound occupied solely by a species of *Rhinotermes*, but in the light of further knowledge I now consider this termitarium to have been the work of a species belonging to some other genus and that termitaria are never constructed by *Rhinotermes*. All the evidence to hand is in support of the contention that the nest is situated at some considerable depth below the surface of the ground, possibly 4 or 5 feet, since none of the scores of colonies in logs, trees, and posts, investigated here and elsewhere, have contained eggs or royal forms, though young larvae and nymphae are frequently present with the soldiers and workers.

Of the two forms of soldiers the smaller appear to outnumber the larger in about the proportion of 4 to 1, the total of the two being about 25% of the workers. Both forms contain individuals of male and female sex, the smaller form being the most active and aggressive.

A few alate male and female imagos were captured at a lamp in a Townsville residence on each of the following nights:—3/3/19, 8/12/19, 7/1/20, 15/2/20, 5/3/20, 24/1/21, 26/1/21, 8/2/21, 28/2/21, 2/3/21, 8/3/21, 10/3/21, 7/4/21. On 24th January and 8th March many alate male and females were taken under the clayey casing enveloping fence posts in Townsville and on 21st February still greater numbers were found under somewhat similar circumstances at Rollingstone. In each case the wood had been seriously damaged. The winged forms, like the soldiers and workers, are very active and when disturbed retreat rapidly to cracks and crevices, preferring to hide rather than to take wing.

Named in honour of Dr. Anton Breinl, formerly Director of the Australian Institute of Tropical Medicine.

Loc.—N. Queensland: Rollingstone, Townsville (G. F. Hill); ? N.W. Australia: Kimberley (Dr. E. Mjöberg).

Subfamily TERMITINAE.

Genus EUTERMES Fr. Mull.

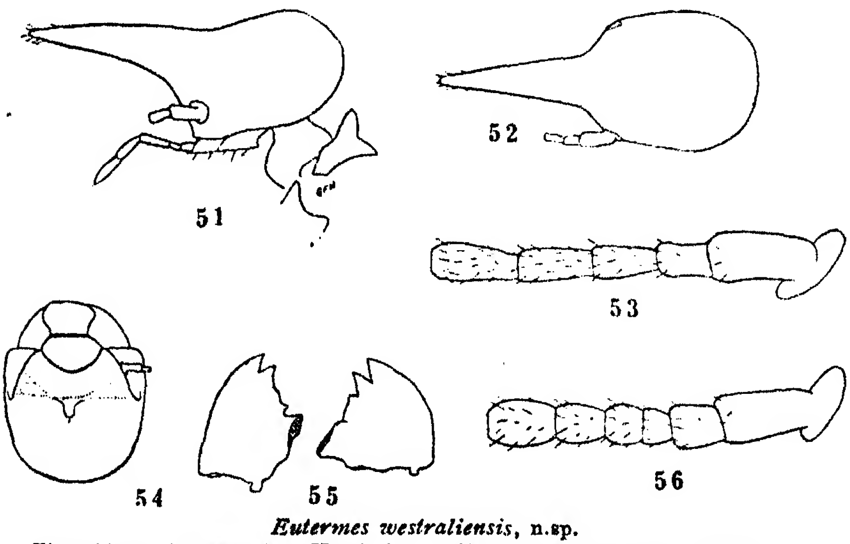
EUTERMES WESTRALIENSIS, n. sp. (Figs. 51-56.)

Imago.

Not known.

Soldier. (Figs. 51-53.)

Colour: Head very dark, almost black; rostrum rather darker than posterior portion; antennae, thorax, femora, and tergites of abdomen mummy brown; under surface, tibiae, tarsi, and palpi dresden brown.



51 52 53 54 55 56

Eutermes westraliensis, n.sp.

Figs. 51-53. Soldier. 51. Head in profile; 52. Head from above; 53. Antennae, proximal segments.

Figs. 54-56. Worker. 54. Head; 55. Mandibles; 56. Antennae, proximal segments.

Head (Figs. 51 and 52) very long and slender, rounded behind, sloping on the sides to the long, stout rostrum; rostrum as long as remainder of head, slightly convex above in the profile; front of head depressed; a few short setae

on rostrum, remainder of head almost bare. Antennae (Fig. 53) very long (3.10) and slender, 15-jointed (*rarely 14-jointed*), 1st joint more than twice as long as 2nd, 2nd shortest, 3rd and 4th generally subequal, or 3rd sometimes markedly longer than 4th, 5th a little longer than 4th, slightly turbinate like succeeding joints, 6th longer than 5th, 7th and 8th longer, subequal, 9th, 10th, 11th and 12th longest of all, twice as long as 2nd, 13th and 14th shorter, subequal, equal to 6th, 15th shorter than 14th, as long as 4th, 16th shorter than 15th, bluntly rounded at apex.

Thorax with shining, minutely-wrinkled surface, clothed very sparsely with very small setae invisible under hand lens. Pronotum: Saddle-shaped anterior margin with a few minute setae, otherwise bare; anterior margin bent up sharply, bilobed in front, very dark in colour, antero-lateral angles rounded, sides sloping to the nearly round posterior margin; posterior half broadly margined with mummy brown, median suture and small spot in middle pale. Mesonotum reniform, a little narrower than pronotum, half as long as wide. Metanotum much wider but shorter than mesonotum, nearly three times as wide as long.

Legs very long and slender, almost cylindrical, as dark as thorax when viewed from above, sparsely clothed with short fine setae.

Abdomen very little contracted at base and not markedly wide in middle, rounded at apex; apices of tergites with a few short fine setae, remainder clothed with minute setae. Cerci very long and slender.

Measurements:

Total length 4.50.
Head, long 1.88; wide 0.987.
Pronotum, long 0.330; wide 0.564.
Tibia i. 1.410; ii. 1.457; iii. 2.021.
Abdomen, wide 1.175.

Worker. (Figs. 54-56.)

Colour: Head sepia, with clear median suture extending from the posterior margin to the fontanelle, where it divides in the shape of the letter "U," each arm extending laterally across the head to a clear area lying midway between the posterior margin of the antennal fossae and the fontanelle; clypeus buffy brown; labrum yellow, thorax and abdomen slightly paler than in soldier; legs whitish.

Head (Fig. 54) moderately large, almost hairless, rounded behind and on the sides, widest in front, flat on the summit. Clypeus twice as wide as long, strongly convex behind, truncate in front, with obscure median suture. Anteclypeus hardly visible. Labrum narrow at base, swollen on the sides, truncate in front, not quite covering the apical teeth of mandibles. Mandibles (Fig. 55). Antennae (Fig. 56) long and slender, 17-jointed, 3rd joint shortest of all, 4th and 5th subequal, 6th much longer.

Thorax very similar to that of soldier, a little paler in colour.

Legs long and slender, with sparse clothing of fine setae.

Abdomen short and narrow, with dark tergites, as in soldier. Cerci of moderate length.

Measurements:

Total length 5.50.
Head from base to posterior margin of clypeus, long 1.269; wide 1.504.
Pronotum, long 0.517; wide 0.799.
Tibia i. 1.316; ii. 1.410; iii. 2.068.
Abdomen, wide 1.05.

Affinities: This species is easily distinguished from all previously described Australian *Eutermes* by the shape of the head of the soldier. Additional characters which serve to differentiate it from nearly all other species are:—its nearly black head, very long, slender, dark legs and antennae and the distinctly banded appearance of the abdomen. Some, or perhaps all, of these latter characters occur in a few Northern Australian species; but never in conjunction with a remarkably long rostrum and slender head.

Biology: I am indebted to Mr. J. Clark for the following information:—The termitaria are numerous on the open, sandy, coastal plains and on the Darling Range. They vary in shape, some being narrow and conical, others wide and flat. The average size is about 10-12 inches high and 16-18 inches wide at the base, but occasionally they are twice this size. In many cases they appear to be built upon roots or stumps. The outer walls are about one and one-half inches thick and protect an interior composed of very large cells or chambers, all of which are filled with short lengths of grass. There appears to be neither "nursery" nor queen cell in the super-structure and as the mature reproductive forms have not yet been discovered in any of the nests examined it is probable that the termitarium serves the purpose of a storehouse only. When the nests are broken the workers appear to be more aggressive than the soldiers, and are often noticed running about holding other species in their jaws.

In the nests of many species of *Eutermes* there is no regular queen-cell, the ovigerous female ovipositing in any of the large cells towards the outer walls that are not already filled with "chaffed" grass. In others the termitarium serves as a storehouse and nursery, the queen and eggs being located below the surface of the ground, as would appear to be the case in the species described above. It is by no means a rare occurrence to find two or more species of termites living in one termitarium, but Mr. Clark's record of five species is very unusual. *Hamitermes obeuntis* Silv. and *Mirotermes kraepelini* Silv. are often associated in the nests of other species, but in one nest of *Eutermes westraliensis* there were found, in addition to the two above species, *Leucotermes*, n. sp. and *Eutermes ? apiocephalus* Silv.

Loc.—S.W. Australia: Gosnells, Kalamunda, Wongong (J. Clark).

References in addition to those quoted in the text.

HILL, G. F., 1921.—*Coptotermes raffrayi* Wasman. *Proc. Linn. Soc. N.S. Wales*, xlvi., Pt. 2, pp. 263-267.

—On some Australian Termites of the genera *Drepanotermes*, *Hamitermes* and *Leucotermes*. *Bull. Entomological Research* (In the Press).

EXPLANATION OF PLATE XXXVI.

Fig. 4. *Stolotermes victoriensis*, n.sp. Wings.
Fig. 23. *Calotermes (Glyptotermes) ? obscurus* Walker. Wings.
Fig. 25. ,, ,, ,, Portion of median vein and membrane.
Fig. 26. *Calotermes (Cryptotermes) primus*, n.sp. Wings.

NOTES ON, AND DESCRIPTIONS OF AUSTRALIAN FISHES. NO. 2.

By Allan R. McCulloch, Zoologist, Australian Museum.

(By permission of the Trustees of the Australian Museum).

(Plates xxxvii.-xli. and three Text-figures.)

The following paper is a collection of miscellaneous notes and descriptions similar to that of Part 1, published in These Proceedings, Vol. xl., pp. 260-277. Most of the fishes dealt with have been hitherto insufficiently described and imperfectly known, and are therefore here figured and redescribed in detail. The synonymy of several has been studied, and is presented in a new form, while others are recorded from Australian waters for the first time. One is regarded as a new species.

Family CARCHARHINIDAE.

Carcharhinus macrurus Ramsay & Ogilby. (Plate xxxvii., figs. 1-4).
Whaler.

? *Carcharias brachyurus*, Günther, Brit. Mus. Cat. Fish., viii., 1870, p. 369—Australian specimen only (*vide* Ogilby, Proc. Linn. Soc. N.S. Wales, (2), iii., 1889, p. 1768).

Carcharias brachyurus, Ramsay, Proc. Linn. Soc. N.S. Wales, v., 1880, p. 96; Macleay, Proc. Linn. Soc. N.S. Wales, vi., 1881, p. 352 (not description); Ogilby, Cat. Fish. N.S. Wales, vi., 1886, p. 1; Waite, Mem. N.S. Wales Nat. Club, ii., 1904, p. 7. (Not *C. brachyurus* Günther).

Carcharias macrurus, Ramsay & Ogilby, Proc. Linn. Soc. N.S. Wales, (2), ii., 1887, pp. 163, 1024; and iii., 1889, p. 1768.

Carcharinus brachyurus, Waite, Rec. S. Austr. Mus., ii., 1, 1921, p. 12, fig. 8. (Not *C. brachyurus* Günther).

Body rather slender, its depth before the dorsal fin 5.6 in the length to the base of the tail; the length from the snout to the front margin of the vent is 1.8 in the total. Head, to the level of the first gill-opening, 2.6 in the trunk, and 5.1 in the total length. Preoral length 0.1 greater than the width of the mouth.

Snout rather long, obtusely pointed in the horizontal plane. Nostrils nearer to the mouth than to the end of the snout, and separated by a space which is equal to the distance of their inner angles from the end of the snout.

Mouth one-third longer than wide, its greatest width 1.1 in the preoral length; a very short groove extends forward on each side near the posterior angle. Eye 1.4 in the width of the third gill-opening, its anterior margin a little farther forward than the front of the mouth. The distance between the front margin of the eye and the end of the snout, measured obliquely, is equal to that from the eye to the first gill-opening. The two posterior gill-openings are above the base of the pectoral, and the last is about three-fourths as wide as the third. Upper teeth triangular, very oblique laterally, and serrated on both edges; their outer edges are more or less notched, the angle being much greater in those on the sides than near the symphysis. Lower teeth narrow, erect, and more or less obscurely serrated. Scales around the shoulder region armed with three points on their hinder margins, from which three ridges extend forward; they are attached by short three-pronged roots.

The dorsal fin is midway between the end of the snout and the base of the tail, and its hinder angle is produced backward as an acute lobe. The space between the two dorsals is more than three times as great as that separating the hinder base of the second dorsal and the base of the tail; the second dorsal is a little smaller than the anal, and is produced into a sharp point posteriorly. Inner angle of the pectoral not quite reaching the vertical of the origin of the dorsal, and the tip of the fin does not attain the vertical of the hinder angle of the dorsal base when laid back. Ventrals subquadrangular, a little nearer the anal than the vertical of the first dorsal. Anal originating slightly in advance of the vertical of the second dorsal, its posterior angle produced. Caudal a little longer than the space between the posterior angles of the bases of the two dorsals; a pit above and below the caudal peduncle.

Colour.—Grey above, with traces of a narrow darker longitudinal stripe on each side above the lateral line; white below. The tips of the second dorsal and the lower caudal lobe are darker than the remainder of the fins.

Described and figured from a female specimen 877 mm. long, from Botany Bay.

Identity.—Though this specimen differs slightly from the original description of *C. macrurus*, a comparison with the holotype in the Australian Museum proves it to be correctly identified. Both specimens are about the same size, and they agree in all details which have not been distorted in the type, which is stuffed.

Status.—Waite (Rec. Aust. Mus., vi., 3, 1906, p. 226) has united this species with *C. brachyurus* Günther, though, as is evident from his remarks, he did not examine either the holotype or any other of the several specimens of *C. macrurus* which were available to him. The two species appear to differ considerably in the length of the snout and the size of the eye. In *C. macrurus*, the preoral length is greater than the width of the mouth, and the eye is much more than half as wide as the gill-opening. In *C. brachyurus*, according to Günther, the preoral length is equal to about two-thirds the width of the mouth, and the gill-openings are at least twice as wide as the eye.

It may be noted here that the specimen figured in Waite's paper (*Loc. cit.*) as *C. brachyurus* differs in several details from the description of that species, and is probably incorrectly identified.

Localities and *Distribution.*—The specimen described above was taken in a net at Botany Bay, New South Wales, by Mr. J. H. Wright, in February, 1921. Several others, including the holotype, are in the Australian Museum from Port Jackson. As *C. brachyurus*, the species has been recently recorded from South Australia by Waite.

GALEORHINUS AUSTRALIS Macleay. (Plate xxxvii., figs. 5-7).

School Shark.

Galeus canis, Günther (part), Brit. Mus. Cat. Fish., viii., 1870, p. 379 (Tasmanian specimen only); Klunzinger, Arch. Naturg., xxxviii., 1, 1872, p. 45 & Sitzb. Akad. Wiss. Wien, lxxx., 1, 1879, p. 426; Castelnau, Proc. Zool. Soc. Vict., i., 1872, p. 216; Johnston, Proc. Roy. Soc. Tasm., 1882 (1883), p. 137, and 1890 (1891), p. 38.

Galeus sp., McDonald, Proc. Zool. Soc., 1873, p. 312.

Galeus australis, Ramsay, Proc. Linn. Soc. N.S. Wales, v., 1880, p. 96 (*nom. nud.*); Macleay, Proc. Linn. Soc. N.S. W., vi., 2, 1881, p. 354; McCoy, Prodr. Zool. Vict., dec. vii., 1882, Pl. lxiv., fig. 2; Ogilby, Ed. Fish. N.S. Wales, 1886, p. 2, and Proc. Linn. Soc. N.S. Wales, (2), iii., 1889, p. 1769; Lucas, Proc. Roy. Soc. Vict., (2), ii., 1890, p. 42; Waite, Rec. Canth. Mus. i., 1, 1907, p. 7, and i., 2, 1909, p. 9, Pl. xv.; Zietz, Trans. Roy. Soc. S. Austr., xxxii., 1908, p. 290; Ogilby, Proc. Roy. Soc. Qld., xxi., 1908, p. 23 and Mem. Qld. Mus., v., 1916, pp. 78, 93; McCulloch, Zool. Res. Endeavour, i., 1, 1911, p. 9; Regan, Brit. Antarc. Exped., Zool., i., 1, 1914, p. 14; Waite, Rec. S. Austr. Mus., ii., 1, 1921, p. 13, fig. 12.

Galeorhinus australis, Waite, Mem. Austr. Mus., iv., 1, 1899, p. 34.

Mustelus australis, Waite, Mem. N.S. Wales Nat. Club, No. 2, 1904, p. 7.

Eugaleus australis, Waite & McCulloch, Trans. Roy. Soc. S. Aústr., xxxix., 1915, p. 460.

Snout obtusely pointed and depressed, its preoral length 2.4 in the length of the head to the first gill-opening; its lateral edges anterior to the nostrils are moderately sharp. Nostrils much nearer the upper lip than the end of the snout, the space between them 1.44 in their distance from the tip of the snout; the anterior margin of each has a small lobule projecting backward. Anterior margin of the mouth in advance of that of the eye; the width of the mouth is equal to its distance from the end of the snout, and there is a longer upper and a shorter lower labial fold at each angle. Eye with a nictitating membrane, its diameter about 3 in its distance from the end of the snout; the skin above the eye forms an imperfect fold. Spiracle a small slit and placed about half an eye-diameter behind the eye. Gill-openings subequal, the fourth widest and equal to the diameter of the eye; the fifth is placed above the base of the pectoral.

About three series of functional teeth in the upper jaw which are smallest anteriorly and larger laterally. The centre cusp of each lateral tooth is oblique, and there is a sharper angle at its junction with the basal portion posteriorly than anteriorly; both the anterior and posterior edges of the base are serrated, but the former less strongly so than the latter. The teeth of the lower jaw are similar to those of the upper, but are rather less strongly serrated.

The first dorsal fin is situated midway between the anterior bases of the pectoral and ventral fins; its upper angle is obtusely pointed, and its posterior angle is produced into a sharp point. The second dorsal and anal are small, and subequal in size and shape; the latter commences below the middle of the former. Caudal equal to about one-fifth of the total length. Pectoral obtusely pointed, almost reaching the vertical of the middle of the dorsal when laid back.

Colour.—Light grey on the back and sides, lighter below. Fins grey like the body.

Described and figured from an adult male 1525 mm. long, which was taken by the State Trawlers in New South Wales waters.

Family RHINOBATIDAE.

TRYGONORRHINA FASCIATA Müller & Henle. (Pl. xxxviii., figs. 1-2).

Fiddler Ray.

Trygonorhina fasciata, Müller & Henle, Plagiost., 1838, p. 124, Pl. xliii.; Dumeril, Hist. Nat. Poiss., i., 2, 1865, p. 502; Günther, Brit. Mus. Cat. Fish., viii., 1870, p. 448; Castelnau, Proc. Zool. Soc. Vict., i., 1872, p. 223; Macleay, Proc. Linn. Soc. N.S. Wales, vi., 1881, p. 373; Johnston, Proc. Roy. Soc. Tasm., 1882 (1883), p. 140, and 1890 (1891), p. 39; Haswell, Proc. Linn. Soc. N.S. Wales, ix., 1884, p. 107, Pl. ii., fig. 1-5 (skeleton); Ogilby, Cat. Fish. N.S. Wales, 1886, p. 5; Lucas, Proc. Roy. Soc. Vict., (2), ii., 1890, p. 45; Hill, Proc. Linn. Soc. N.S. Wales, (2), x., 1895, p. 206, pl. xx. (abnormality) Waite, Mem. Austr. Mus., iv., 1, 1899, p. 39, and Mem. N.S. Wales Nat. Club, ii., 1904, p. 9; Zietz, Trans. Roy. Soc. S. Austr., xxxii., 1908, p. 292.

Trigonorrhina fasciata, Garman, Mem. Mus. Comp. Zool., xxxvi., 1913, p. 287; Waite, Rec. S. Austr. Mus., ii., 1, 1921, p. 27, fig. 39.

Skin velvety, with a band of microscopic tubercles on each side of the back between the shoulders and the first dorsal. A row of eighteen spinous tubercles on the median line of the back before the first dorsal, and two more behind it; a double row of tubercles across the shoulders arranged in pairs, and one before and another behind each eye. Pectoral disc very little narrower than long; the snout is very obtusely pointed, and the outer and posterior margins are rounded. Ventrals wholly separate, their length greater than the distance between their bases anteriorly, but less than their combined widths. Preocular length equal to one-fourth the length of the pectoral disc. The length of the eye is 3½ in the interocular width, and 5 in the preocular length. Spiracle a little larger than, and extending forward around the eye; its postero-exterior margin with a projecting fold. Mouth almost transverse, its width almost equal to three-fourths of the preoral length. Nasoral valve emarginate posteriorly, its width subequal to that of the mouth. Each nostril with a broad posterior lobe and an inner valve. Teeth small, flattened, and smooth, and arranged in a broad band in each jaw. Posterior gill-opening well behind the middle of the pectoral disc.

Tail a little longer than the body, its breadth between the posterior insertions of the ventrals equal to the interocular width; a marked fold commences on each side behind the ventrals and is lost at the base of the caudal. First dorsal scarcely larger than the second, the space between the two subequal to their distances from the insertions of the ventral and caudal fins. Dorsals and caudal obtusely pointed terminally.

Colour.—Light brown above, with an elaborate symmetrical pattern of broad lilac fasciae with dark brown borders arranged as in the accompanying figure. Seven less definite darker cross-bands are arranged as follows:—The first across and on each side of the orbital region; the second much broader and covering the shoulders and surrounding area; the third between the posterior insertions of the pectorals; the fourth between the ventrals; the fifth and sixth at the bases of the dorsals, and the seventh across the tail. Some dark spots on each side of the disc anteriorly and before the eyes. Edges of pectorals and ventrals lilac. Lower surfaces white, the margins of the pectorals and ventrals brown.

Described and figured from a young specimen 380 mm. long, from off Sandon Bluff, New South Wales. It differs from a smaller specimen from Port

Jackson only in having the colour-marking on the back more elaborate, the darker markings and the spots being more developed than is usual.

Family DASYATIDAE.

DASYATIS KUHLII Müller & Henle. (Plate xxxix., figs. 1-2).

Blue-spotted Stingaree.

Trygon kuhlii, Müller & Henle, Plagiost., 1841, p. 164, Pl. li. fig. 1; Day, Fish. India, 1878, p. 739, Pl. cxciii., fig. 2; Ogilby, Cat. Fish. Austr. Mus., 1888, p. 19.
Dasyatis kuhlii, Waite, Mem. N.S. Wales Nat. Club, ii., 1904, p. 11.
Dasybatus kuhlii, Garman, Mem. Mus. Comp. Zool., xxxvi., 1913, p. 395; Ogilby, Mem. Qld. Mus., v., 1916, p. 87.
(*Raya*) *Neotrygon trigonoides*, Castelnau, Proc. Zool. Soc. Vict., ii., 1872, p. 121.

Description of a half-grown male, 243 mm. wide (Pl. xxxix., fig. 1). Pectoral disc rhomboid, its anterior and exterior angles obtusely pointed, the posterior angles sharper; the length is 1.27 in the breadth. Snout thick and short, its length less than the distance between the spiracles. Eye large, almost as long as the spiracle, the length of which is equal to half the interspiracle width. Skin smooth except for four flattened spines on the vertebral line which are close together above the shoulder-girdle. Width of the mouth 1.6 in its distance from the end of the snout. Upper dental lamina undulous, forming a median and two lateral prominences; the teeth are mostly tubercular, but there is a series of larger pointed ones on the convex fold of each side: teeth of the lower jaw in a broad band, flattened, and with minute points directed backward. A broad fringe of tentacles behind the upper jaw, and two papillae behind the lower. Nostrils elongate, each with a free postero-interior lobe; nasoral valve with the posterior margin sinuous and fringed. Posterior gill-opening a little before the middle of the pectoral disc. Ventrals rather elongate, obliquely rounded behind; claspers small, not reaching the level of the end of the ventrals. Tail much longer than the body, with two long spines inserted about their own length behind the ventrals; a short fold on the upper surface behind the end of the spines, and a longer one on the lower surface commencing below the insertion of the spines and becoming gradually lost towards the end of the tail.

Colour.—Light pinkish-brown, with numerous large bluish ocelli having indefinite darker margins; numerous blackish spots are scattered irregularly over the back which are most plentiful around the eyes. A darker band crosses the interorbital region, and appears as an ill-defined blotch on each side of the eyes. Tail darker, becoming blackish terminally, with irregular lighter and darker patches. Lower surfaces uniformly coloured.

A young male, 177 mm. wide (Pl. xxxix., fig. 2), only differs structurally in having the snout a little more pointed and the claspers of much larger size; these extend for half their length beyond the ventral margins; there are six vertebral tubercles. The back is rather darker in colour, and has no light bluish ocelli; the black spots are much more numerous, and closely cover the greater part of the pectoral disc. The darker band across the eyes is much more pronounced, and there are other dark patches on the shoulders, on the nape, and across the snout before the eyes.

Variation.—A fine series of twelve specimens, 129-305 mm. wide, shows that this species undergoes the remarkable colour change with growth described above and illustrated on the accompanying plate. The smaller specimens are profusely speckled with rounded blackish spots as in the young male figured.

and the darker areas around the head and shoulders are very definite. As the fish increases in size, the darker spots and bands are gradually lost, and in the largest specimens of the series comparatively few remain; simultaneously large light bluish ocelli appear and gradually become the most striking feature of the back. The degree of maculation and ocellation varies in each specimen, but the series indicates that the change from the one to the other is the normal condition. The vertebral tubercles are wanting in the youngest specimens, and are more numerous and larger in some of the larger examples than in others.

The development of the claspers varies remarkably. In some large specimens they do not attain the margins of the ventral fins, while in others of similar size, structure, and colouration, they are greatly enlarged and reach far beyond the ventrals; similar variation is presented by the smaller specimens. These two forms are exhibited in the specimens figured, the claspers of the smaller specimen being considerably larger than those of the older example.

Locs.—Off Bustard Head, Queensland, 14-20 fathoms.

This species has been recorded from the Parramatta River estuary by Ogilby. One of his specimens is still preserved in the Australian Museum, which though stuffed and without colour-marking, exhibits the general characters of *D. kuhlii.*

DASYATIS BREVICAUDATUS Hutton. (Text-fig. 2—tail).

Dasyatis brevicaudatus (Hutton), McCulloch, Biol. Res. Endeavour, iii., 3, 1915, p. 102, Pl. xv., fig. 1, and Pl. xvii., fig. 1; Waite, Rec. S. Austr. Mus., ii., 1, 1921, p. 31 (? not fig. 44).

Variation.—Several tails of this species have been examined which exhibit considerable variation in the armature of their upper surfaces anterior to the caudal spine. In three from 20 fathoms off Norah Head, New South Wales, one has six large spine-bearing tubercles in a row, another has one, while the third has none. Another from Coffin Bay, South Australia, and lent to me for examination by Mr. E. R. Waite, is quite similar to those from New South Wales; it is armed with five strong spines directly before the caudal spine. All have the subcaudal lobe well developed, commencing below the base and terminating below the tip of the caudal spine. The spinate tubercles on the sides are smaller than those of *D. thetidis.*

The specimen which is figured by Waite (*vide supra*) is evidently distinct from *D. brevicaudatus,* differing in its much longer tail and colour-marking. Mr. Waite informs me it was not an Australian specimen.

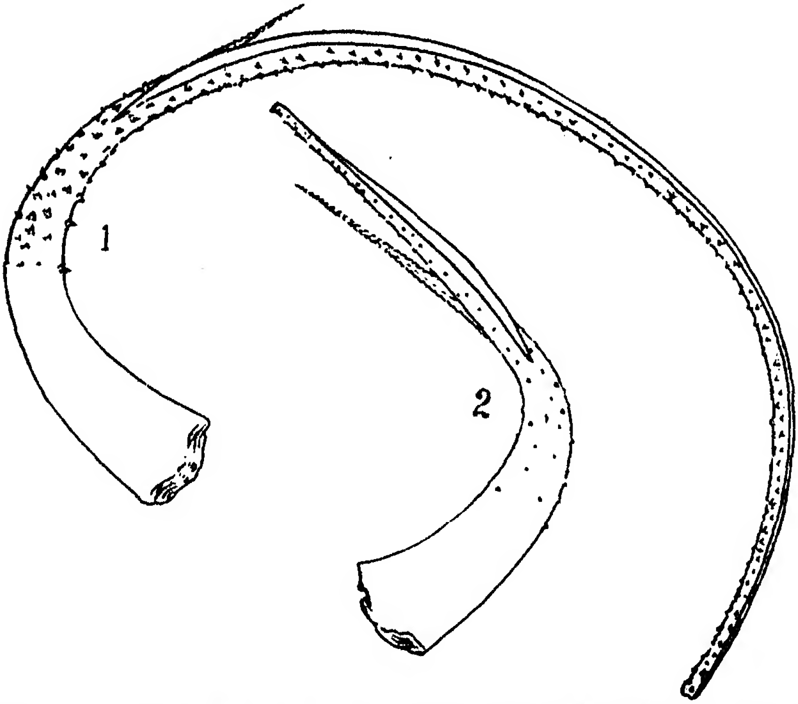
Localities.—Off Norah Head, New South Wales, 20-40 fathoms; coll. F. McNeill, June, 1921; off Botany Bay, New South Wales, 40 fathoms; coll. A. Livingstone, September, 1921; Coffin Bay, South Australia. South Australian Museum.

DASYATIS THETIDIS (Ogilby) Waite. (Plate xl., figs. 1-2; Text-figs. 1 and 3).
Black Skate.

Dasyatis thetidis (Ogilby), Waite, Mem. Austr. Mus., iv., 1, 1899, p. 46.

Disc subquadrangular, wider than long, its length from the tip of the snout to the posterior angle of the pectorals 1.23 in the breadth. Snout a little prominent. Anterior margins slightly sinuous, feebly convex on each side of the snout and then very slightly concave; outer angles distinct but rounded. Postero-lateral borders of the disc a little convex, nearly straight, and forming obtuse angles with the inner margins of the pectorals. Ventrals subquadrangular, the edges rounded. A row of seven strong rounded or oval stellate tubercles

along the median line of the back, each of which is armed with a stout depressed spine worn smooth on its upper surface; the first is midway between the eyes and the scapular region; three more are in advance of the scapular region, and three others are close together in the middle of the back. A single small spinate tubercle is present on the right side of the scapular region.



Text-fig. 1. Under surface of the tail of *Dasyatis thetidis*, from off Norah Head, New South Wales, 20-40 fathoms.

Text-fig. 2. Under surface of the tail of *Dasyatis brevicaudatus*, from the same locality.

Tail depressed before, cylindrical behind the spine, its length from the middle of the vent 0.44 longer than the body. A row of tubercles armed with large spines commences on the median dorsal line in advance of the margins of the ventrals, but the rest of the tail is smooth anteriorly; smaller spinate tubercles appear on the sides and upper and lower surfaces well in advance of the spine, and become more and more numerous backwards. A low cutaneous and minutely spicular fold commences slightly in advance of the insertion of the caudal spine, and extends backward to the end of the tail; it is deepest anteriorly where it is about one-fourth as deep as the tail above it, and decreases gradually backward.

Eyes very small, the space between them equal to the greatest width between the spiracles; they are 4.2 in the bony interorbital space, which is slightly more than half the preorbital length. Spiracles very large, longer than broad, their length 1.5 in the interorbital width.

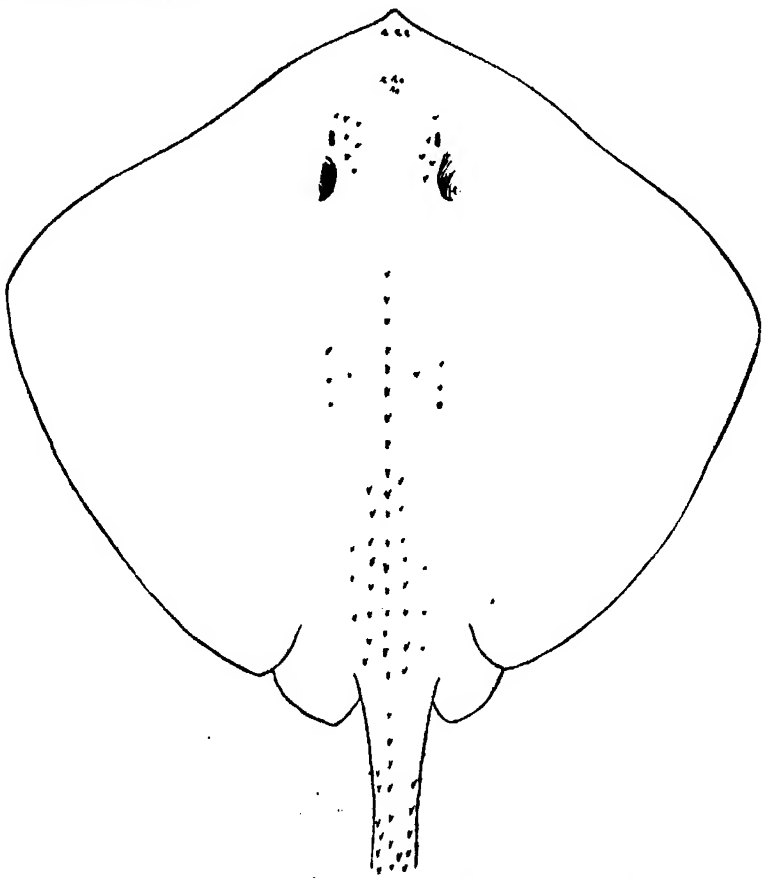
The space separating the nostrils is 1.3 in their distance from the end of the snout. Outer angles of the internasal lobe rounded; a narrow flap is folded

forward from its posterior margin which is minutely lobulated and is divided into two on the median line. Width of the mouth 2.5 in the preoral length. Teeth small without cusps. A broad lobulated flap inside the mouth behind the upper jaw, and five papillae inside the lower one, of which the two outer ones are small and widely separated from the other three. Four anterior gill-slits subequal in width, the second slightly wider than the others; the fifth is about three-fourths as wide as the first.

Length of body 645 mm., length of tail 945 mm., and width of disc 890 mm.

Colour.—Uniform greyish-brown above, with a row of small white pores on each side of the back. Tail black posteriorly. Lower surfaces white.

Described and figured from a female specimen which was trawled off Norah Head, New South Wales, in 20-40 fathoms. A tail of another specimen (Text-fig. 1), together with several of *D. brevicaudatus* (Text-fig. 2), were procured from the same locality.



Text-fig. 3. Sketch of a female *Dasyatis thetidis*, 70 inches wide, from east of Babel Island, Bass Strait, 60 fathoms.

Variation.—The number of the spinate tubercles is apparently very variable in this species. They are few in number in the specimen described, but a strip of skin is preserved in the "Endeavour" collection, which was taken from a

specimen evidently referable to *D. thetidis,* which has an unbroken row of about fifty tubercles between its anterior end and the caudal spine, of which ten are in advance of the scapular region. The accompanying figure (Text-fig. 3) is a sketch I made of a large female, 70 inches wide, which was trawled by the "Endeavour" in sixty fathoms East of Babel Island, Bass Strait, and which was thrown overboard after I had made notes upon it. The disc was smooth above, except along the median portion, where there were several rows of large tubercles bearing spines; a few tubercles were close to the snout, and a few more midway between the snout and the eyes; in front of and above the eyes were others which differed in number on each side; twenty inches behind the snout and well behind the level of the spiracles a median row of tubercles commenced, which was supplemented on the shoulders by some parallel spines; behind the middle of the disc the tubercles were arranged in four irregular rows which were gradually reduced to two at the level of the ventrals. The tail was intensely spiny, and there was a narrow fold on the under surface from the level of the caudal spine to its end, about half an inch wide; the tail was forty-six inches long but incomplete. The teeth were without cusps.

Synonymy.—Garman (Mem. Mus. Comp. Zool., xxxvi., 1913, p. 383) has included *D. thetidis* in the synonymy of his *D. latus* and the two species are certainly very similar. But the tail is more than twice as long as the body in *latus* and is apparently less spiny than in *thetidis,* in which it is not much longer than the disc. It is improbable also that a species occurring in moderately deep water off the south-eastern coast of Australia should be identical with a species from the warm waters of the Hawaiian Islands.

Ogilby (Mem. Austr. Mus., iv., 1, 1899, p. 46, and Proc. Roy. Soc. Qld., xxi, 1908, p. 8) has suggested that the specimen recorded by Günther (Brit. Mus. Cat. Fish., viii., 1870, p. 480) from Sydney as *Trygon tuberculata* is referable to *Dasyatis thetidis,* but it is more probably an example of *D. fluviorum* Ogilby. Günther described the tail as more than twice the length of the disc, and usually provided with a dorsal as well as a ventral cutaneous fold; the spines on the tail were said to be minute. In all these characters the specimen differs from *D. thetidis* while agreeing with *D. fluviorum.*

D. thetidis differs from *D. brevicaudatus* in the following characters:—

A. Disc with more or less numerous spinate tubercles on the middle of the back. Eyes not closer together than the spiracles. Internasal space shorter than the distance between the nostrils and the end of the snout; outer angles of internasal lobe rounded. Tail longer than the disc; a narrow cutaneous fold on its lower surface extending backward to its tip. Tubercles and spines large .. .. *thetidis*

AA. Disc entirely smooth, without spines on the back. Eyes closer together than the spiracles. Internasal space almost equal to the distance between the nostrils and the end of the snout; outer angles of internasal lobe pointed. Tail shorter than the disc; a cutaneous fold on its under surface which terminates below the end of the spine. Tubercles and spines smaller .. .. *brevicaudatus.*

Occurrence.—*D. thetidis* and *D. brevicaudatus* are apparently common in depths down to sixty fathoms off the coast of New South Wales where they are taken by the State trawlers, and find a ready sale as Black Skate. I have also seen them trawled off the eastern coast of Tasmania, one or more occurring in each haul of the net, but the differences between the two not having been recognised, nothing is known as to which species is the most abundant.

Locality.—Off Norah Head, New South Wales, 20-40 fathoms; coll. F. McNeill, June, 1921.

UROLOPHUS BUCCULENTUS Macleay. (Plate xli., fig. 1-3).

Sandy-backed Stingaree.

Urolophus bucculentus, Macleay, Proc. Linn. Soc. N.S. Wales, ix., 1885, p. 172; McCulloch, Biol. Res. Endeavour, iv., 4, 1916, p. 177.

Trygonoptera bucculenta, Waite, Mem. Austr. Mus., iv., 1, 1899, p. 44, Pl. v.

Breadth of the disc 0.4 greater than its length from the end of the snout to the end of the pectoral fins. Tail, measured from its end to the middle of the vent, 1.4 in the length from the same point to the end of the snout, and slightly shorter than its distance from the mouth. Interocular and interspiracle widths subequal, 1.4 in the preocular portion of the head. Internasal width 2, and width of mouth 2.1 in the preoral length.

Breadth of the disc much greater than its length from the end of the snout to the tip of the ventral fins. Snout imperfect—forming a sharp and slightly projecting angle in the type. Anterior pectoral margins almost straight, the outer angles rounded; posterior-lateral margins convex, their junction with the inner margins rounded. Eyes prominent, rather large, their length less than half the interocular width. Intero-superior margin of the spiracle almost straight without any angular projection. Nostrils without free lobes posteriorly and separated by a wide space from the angle of the mouth. Posterior margin of the internasal valve minutely lobulate but not fringed; the postero-external angles form lobes which lie in grooves outside the lips. Teeth uniformly tessellate in the female. A fimbriated velum behind the upper teeth, and a row of about sixteen papillae behind the lower teeth some of which are paired.

Tail depressed, with a well developed fold on each side extending backward to the origin of the spine; its width at the base is slightly less than that of the mouth. The spine is inserted at the middle of its length, and in front of its base is a well developed dorsal fin. Caudal fin large and rather narrow; it originates below the hinder third of the spine on the upper surface, and extends forward as a ridge to beneath the anterior third below.

Colour.—Light pinkish tan above, the posterior portions of the pectorals and ventrals lighter. Whitish spots and short lines are distributed over the back and greater portion of the disc, but the snout and a broad pectoral margin are unmarked; the spots are very small and close together on the outer portion of their area but become larger interiorly and change into short vermiculating lines on the branchial regions and back. Ventral fins with small white spots. Tail with one median and two supero-lateral light stripes; the lateral folds white. Vertebral region of the caudal fin white marbled.

Described and figured from a female example 600 mm. wide. The snout, end of the caudal fin, and portion of the ventrals being damaged in this specimen, these details have been completed from the types.

Identity.—The cotypes of this species have been skinned and are in a very imperfect state of preservation. But a comparison of them with the specimen described and figured leaves no doubt that the latter is correctly identified.

Locality.—East of Botany Bay, New South Wales, 60 fathoms; May, 1920.

Family NARCOBATIDAE.

Genus HYPNARCE Waite.

Hypnos, Dumeril, Rev. Mag. Zool., (2), iv., 1852, p. 279—Orthotype *H. subnigrum* Dum. (Not *Hypna* Hubner, 1816); Günther, Brit. Mus. Cat. Fish., viii., 1870, p. 453; Macleay, Proc. Linn. Soc. N.S. Wales, vi., 1881, p. 374; Ogilby, Mem. Qld. Mus., v., 1916, pp. 83, 92.

Hypnarce, Waite, Rec. Austr. Mus., iv., 5, 1902, p. 180—substitute name; Garman, Mem. Mus. Comp. Zool., xxxvi., 1913, p. 303; Jordan, Gen. Fish., ii., 1919, p. 250.

HYPNARCE SUBNIGRA Dumeril. (Pl. xxxviii., figs. 3-4).

Numbfish.

Hypnos subnigrum, Dumeril, Rev. Mag. Zool., iv., 1852, p. 279, Pl. xii., and Hist. Nat. Poiss., i., 2, 1865, p. 520; Günther, Brit. Mus. Cat. Fish., viii., 1870, p. 453; Macleay, Proc. Linn. Soc. N.S. Wales, vi., 1881, p. 374, and vii., 1882, p. 12; Woods, Fish & Fisher. N.S. Wales, 1882, p. 100; Haswell, Proc. Linn. Soc. N.S. Wales, ix., 1884, p. 104, Pl. xi., figs. 6-9 (skeleton); Ogilby, Cat. Fish. N.S. Wales, 1886, p. 5; Fritsch, Elektrisch. Fische., ii., 1890, p. —, and Sitzb. Akad. Wiss. Berlin, 1895, pt. xxi., p. 423; Howes, Proc. Zool. Soc., 1890, p. 669, Pl. lvii. (visceral anatomy); Waite, Mem. Austr. Mus., iv., 1, 1899, p. 42, and Mem. N.S. Wales Nat. Club, ii., 1904, p. 10; Zietz, Tr. Roy. Soc. S. Austr., xxxii., 1908, p. 292; Ogilby, Mem. Qld. Mus., v., 1916, p. 83, and vi., 1918, p. 104.

Hypnarce subnigra, Waite, Rec. Austr. Mus., iv., 1902, p. 180; Garman, Mem. Mus. Comp. Zool., xxxvi., 1913, p. 304.

Skin perfectly smooth, flesh soft and flabby. The width of the pectoral disc is subequal to its length. Anterior margin of the snout thick and almost straight, a slight notch at its junction with the pectoral on each side; pectoral margins evenly curved and thin. Ventrals much longer than broad, united below the tail, and together forming a disc which is broader than long; claspers reaching a little beyond their margins. The distance between the eyes and the anterior margin is equal to about twice the width of the interocular space. Spiracles directly behind and slightly larger than the eyes, their margins surrounded by coarse papillae. Mouth forming three parts of a circle, its front margin a trifle in advance of that of the eyes; its width is less than the preoral length. Nostrils with thick raised margins which form narrow lobes posteriorly; nasoral valve square cut, its posterior margin sinuous. Posterior gill-opening behind the middle of the pectoral disc. Each jaw with a broad band of small flattened and acutely tricuspid teeth, the median cusp of which is much longer than the others. Dorsals leaf-like, the first commencing well before the centre of the ventral disc, and not much smaller than the second which is immediately behind it. Caudal as broad as long, rounded, and just overhanging the margin of the ventral disc. Tan-brown above, white below.

Described and figured from a beautifully preserved specimen, 353 mm. long, from off Cape Hawke.

Variation.—Eight specimens 126-440 mm. long, exhibit but little variation. The relative size of the dorsal fins is a little variable, the first being sometimes markedly smaller than the second, and the eyes are sometimes a little nearer the end of the snout than in the specimen described. The general proportions of all appear to be very similar. Most are light brown in colour on the upper surface, but the smallest specimen has small light spots closely distributed over the back, while two others are darker, one being almost chocolate brown above.

Habits.—In September, 1919, I saw a living female of this species in shallow water at Port Stephens, New South Wales, which was about twenty inches long, and of a clear tan colour above and white below. When disturbed it buried itself with great rapidity beneath the sand, and though only covered by a few inches of water, completely hid itself from view. In throwing it out onto the beach with a wet board, I received a sharp shock which resembled a blow on the biceps. After stranding it, I and others received about fifty successive shocks in a space of about ten minutes before we killed it by severing its spine. The shocks were intense at first though not painful, and could be felt through one's whole body, but they gradually became weaker; the last dis-

charge was a feeble one, and was produced after the fish had been eviscerated and was apparently dead. Each discharge appeared to be associated with a convulsive contraction of the disc, the edges of the pectorals being turned over towards the middle of the back, and distinct shocks were felt from all parts of the body, including even the ventral fins. By placing a foot upon the disc when the charges were somewhat reduced in power, we felt the shock simultaneously in the same muscles in both legs. A remarkable feature of the electric discharge was that it could be conveyed from the water up a wet stick, or while the fish was lying upon the wet sand; the specimen was finally killed with a knife tied to a dried stick, which conveyed no shocks.

The stomach of this specimen contained nothing but a bright coloured fluid. The small mouth suggests that the species feeds upon smaller animals, but a lobster-fisherman recently assured me that he had taken a large specimen from one of his pots which had curled itself through the opening, and which contained a large Flathead (*Platycephalus*) several inches of which protruded from its mouth.

Locs.—Four specimens are preserved in the "Endeavour" collection from the following localities:—Six miles East of Cape Hawke, New South Wales, 47-60 fathoms, 21st June, 1910; Great Australian Bight, edge of bank, 80-120 fathoms, April, 1913.

These have been compared with four others from Port Jackson and the Clarence River Estuary, New South Wales, and Rottnest Island, Western Australia.

Family SERRANIDAE.

EPINEPHELUS CAERULEOPUNCTATUS Bloch.

Holocentrus caeruleopunctatus, Bloch, Ausl. Fische., iv., 1790, p. 94, Pl. ccxlii., fig. 2.

Serranus hoevenii, Bleeker, Verh. Bat. Gen., xxii., 1849, p. 36.

Epinephelus hoevenii, Bleeker, Atlas Ichth., vii., 1875, p. 63, Pls. cclxxxii., cclxxxvi., and ccxc.

Epinephelus caeruleopunctatus, Boulenger, Brit. Mus. Cat. Fish., i., 1895, p. 246 (synonymy).

Colour variation.—Two specimens 56 and 215 mm. long, from off Cape Bedford, Queensland, represent the colour varieties figured by Bleeker as *E. hoevenii* on plates 286 and 282 respectively. A third from Palm Islands, 120 mm. long, is nearer the variety figured on plate 290, its whole head, body and fins being closely covered with small white spots; it is similar to a specimen of about the same size from Batavia which was identified by Bleeker as *E. hoevenii*. Another specimen 120 mm. long, from off Cape Bedford, is somewhat intermediate between the two varieties, having many smaller spots intermingled with the larger ones.

Localities.—This species has not hitherto been recognised from Australian waters. Specimens are in the Australian Museum from North-western Australia; Two Islands, off Cape Bedford, Queensland, coll. Hedley and Briggs, Aug., 1916; Palm Islands, Queensland, coll. E. H. Rainford, 1921; New Hebrides; New Caledonia; Bougainville Island; Batavia.

Family APOGONIDAE.

APOGON TRIMACULATUS Cuvier & Valenciennes.

Apogon trimaculatus, Cuvier & Valenciennes, Hist. Nat. Poiss., ii., 1828, p. 156, Pl. xxii; Castelnau, Res. Fish. Austr. (Vict. Offic. Rec. Philad. Exhib.), 1875, p. 9.

Amia trimaculata, Bleeker, Atlas Ichth., vii., 1875, p. 80.
? *Amia rhodopterus*, Bleeker, *Ibid.*, 1876, p. 81, Pl. cccxii., fig. 1.
? *Amia koilomatodon*, Bleeker, *Ibid.*, 1876, p. 81, Pl. cccvii., fig. 1; Jordan & Seale, Bull. U.S. Fish. Bur., xxv., 1906, p. 240, fig. 34.

Four specimens in the Australian Museum indicate that *A. rhodopterus* and *A. koilomatodon* are merely colour variations of *A. trimaculatus*. Three of them agree with Jordan and Seale's figure quoted above in the disposition of their colour markings, and particularly in having a small dark spot on each side of the tail; this feature was considered by Bleeker to be characteristic of *A. rhodopterus*. The fourth specimen is quite similar to the others, but has an additional dark spot across the upper part of the caudal peduncle, disposed as in Cuvier & Valenciennes' figure of *A. trimaculatus*.

Localities.—This species has been recognised from Cape York by Castelnau. A fine specimen, 147 mm. long, is in the Australian Museum from Palm Islands, Queensland, which was collected by Mr. E. H. Rainford. Also two others from the New Hebrides, and one from Singapore.

APOGON SAVAYENSIS Günther.

Amia savayensis (Günther), Jordan & Seale, Bull. U.S. Fish. Bur., xxv., 1906, p. 239, fig. 33 (synonymy).

Localities.—This species has not hitherto been recorded from Australian waters. Specimens are in the collection from the following localities:—Murray Island, Torres Strait, coll. Hedley & McCulloch, October, 1907; Palm Islands, and Holborn Island, off Port Denison, Queensland, coll. E. H. Rainford, 1921.

CHEILODIPTERUS MACRODON Lacepède.

Cheilodipterus lineatus, Lacepède, H. N. Poiss., iii., 1802, p. 539, Pl. xxxiv., fig. 1 (Not *Perca lineata* Forskal).
Centropomus macrodon, Lacepède, *Ibid.*, iv., 1802, p. 252, 273.
Paramia macrodon, Bleeker, Atlas Ichth., vii., 1876, p. 105, Pl. cccv., fig. 2 (synonymy).

A fine specimen, 170 mm. long to the end of the middle caudal rays, which was collected at Palm Islands, Queensland, by Mr. E. H. Rainford, enables me to add this species to the Australian list.

Family NEMIPTERIDAE.

SCOLOPSIS TEMPORALIS Cuvier & Valenciennes. (Plate xl., fig. 3).

Scolopsides temporalis, Cuvier & Valenciennes, Hist. Nat. Poiss., v., 1830, p. 341; Lesson, Voy. Coquille, 1826-30, Poiss. Pl. xxvi.
Scolopsis temporalis, Günther, Brit. Mus. Cat. Fish., i., 1859, p. 360; Bleeker, Atlas Ichth., viii., 1876, p. 12; Macleay, Proc. Linn. Soc. N.S. Wales, vii., 1882, p. 239.

D.x/9-10; A.iii/7-8; P.19; V.i/5; C.17 L. Lat. 46+2; 5½ scales between the lateral line and the origin of the dorsal fin, and 18 more to the origin of the anal.

Depth at the ventrals 2.7 in the length to the hypural joint; head 3.1 in the same. Eye 3.2 in the head and 1.1 in the snout, which is 2.8 in the head; interorbital width 1.2 in the eye. Fourth dorsal spine 2.7, seventh dorsal ray 2.1, and pectoral fin 1.2 in the head. Third anal spine 3.2 and first anal ray 2.6 in the head.

Body moderately elevated anteriorly, the profile from the back to the snout slightly convex. Snout rather sharp, the jaws subequal. Scales extend forward on the upper part of the head almost to the level of the posterior nostril; six

rows on the cheek, excluding those on the lower limb of the preoperculum. Maxilla not quite reaching the vertical of the anterior margin of the eye. Preorbital more than half as wide as the eye, and armed with a strong spine, below which are several denticulations. Hinder margin of the preoperculum serrated, its angle projecting a little backward and coarsely denticulated. Operculum armed with a single spine. A band of fine teeth in front of each jaw, which changes to a single row on each side; vomer and palatines toothless.

Lateral line arched anteriorly, then running parallel with the curve of the back until below the end of the dorsal fin, where it descends to the middle of the caudal peduncle. The scales above it are parallel with it, but are arranged in oblique rows on the side of the body. There are four scales between the lateral line and the middle of the spinous dorsal.

The fourth to the tenth dorsal spines are subequal in length, and are shorter than the rays, which increase slightly in length to the seventh; the margin of the fin is not excised between the spinous and soft portions, and is rounded posteriorly. Anal spines increasing in length backward, but the third is shorter than the anterior ray. First ray of the ventral filamentous, reaching beyond the vent. Caudal forked, the upper lobe produced beyond the lower.

Colour.—The general colour appears to have been bright yellow, with violet stripes between each row of scales; these are longitudinal above the lateral line and oblique below it. The dorsal profile between the nape and the end of the fin is dark violet. Head yellow, darker above, with broad blue stripes; two of these cross the snout between the eyes, and a third extends from the upper lip to the lower margin of the eye, and terminates in an expansion on the upper part of the preoperculum; another band passes obliquely across the cheek to the operculum, where it bends sharply downward and forms an acute angle. Spinous dorsal with a yellow margin, followed by a pale violet submarginal band, beneath which the membrane is iridescent with yellow and violet; second dorsal and anal colourless. Pectoral with a dark brown streak across its base. First ventral ray yellow, the rest of the fin white. Caudal yellow, with a violet stripe on each lobe, the upper of which is separated from the outer margin; a violet border posteriorly.

Described and figured from a specimen 172 mm. long to the end of the middle caudal rays.

This example is apparently referable to *S. temporalis*, though it differs in several details from Lesson's rather crude figure quoted above. I have compared it with two specimens recorded by Macleay under the same name from Port Moresby, and find it identical. The species has not hitherto been recognised from Australian waters.

Locality.—Palm Islands, Queensland, coll. E. H. Rainford.

Family LABRIDAE.

INIISTIUS PAVONINUS Cuvier & Valenciennes.

Xyrichthys pavoninus, Cuvier & Valenciennes, Hist. Nat. Poiss., xiv., 1839, p. 63.
Iniistius pavoninus Jordan & Evermann, Bull. U.S. Fish. Comm., xxiii., 1, 1905, p. 329, fig. 139, and pl. xlii. (synonymy).
Iniistius cacatua Waite, Rec. Austr. Mus., iv., 1, 1901, p. 41, Pl. vii.

Synonymy.—A comparison of the holotype of *I. cacatua* with a smaller Hawaiian specimen which is evidently *I. pavoninus* shows them to be similar in all details except the position of the anterior dorsal spine. This is a little farther back in the larger example, but is not so far back as is illustrated in

Waite's rather crude figure, which is inaccurate in other details, such as the backward extension of the mouth and the relative length and depth of the head.

Localities.—Lord Howe Island; holotype of *I. cacatua.* Honolulu, Hawaiian Islands.

Subfamily ELEOTRINAE.

PARIGLOSSUS RAINFORDI, n.sp. (Plate xli., fig. 4).

D.v/17; A.16; P.18; V.i/4; C.15. Depth at the ventral fins 5.2 in the length to the hypural joint; head 4.5 in the same. Eye 3.5 in the head. Depth of the caudal peduncle 1.7 in the head. Third dorsal spine a little longer than the head. Sixth dorsal ray 1.7, eighth anal ray 1.5, and pectoral fin 1.4 in the head.

Body rather elongate, compressed; head compressed, much deeper than broad. Snout tumid, the mandible in advance of the premaxillaries. Mouth nearly vertical, the maxilla not reaching the vertical of the anterior margin of the eye. Head entirely naked, with several pores above the eye and on the preopercular margin. No barbels. Gill-opening lateral and vertical, a little wider than the base of the pectoral; gill-membranes broadly united with the isthmus. Tongue broad, spatulate, its anterior margin rounded. Eye in the anterior half of the head, its diameter much greater than its distance from the end of the snout and equal to the interocular space, which is convex. Premaxillaries with a row of about seven large outer teeth on each side of the symphysis which increase in size backwards; inside these is a narrow band of minute teeth on each ramus. Mandible with a pair of large canines on each side; a narrow band of minute teeth anteriorly, and a single row of still smaller ones on each side.

Body largely covered with minute imperfect scales which extend forward to the shoulder, but leave the nape naked; they are rudimentary on the abdominal surface. No lateral line. A minute genital papilla.

First dorsal originating just behind the vertical of the middle of the pectoral; its third spine is longest and filamentous, and together with the fourth, reaches beyond the origin of the second dorsal when adpressed. Margin of the second dorsal somewhat rounded, the last rays reaching backward to the hypural joint. Anal opposite and similar to the second dorsal. Pectorals rather short, rounded. Ventrals close together, but separate, composed of one spine and four rays; the inner ray is simple and filamentous, but does not reach the vent. Caudal rounded.

Colour-marking.—General colour light green, with a dark bluish-black marking on the base of the caudal fin. A violet brown band usually extends along the middle of each side, but may be indistinct. A brown spot behind the eye, and several pale blue ones on the cheek and operculum. First dorsal pinkish, its prolonged rays white; second dorsal dark violet basally, then yellow, with a broad pink border. Anal bright yellow, bordered with pink. Caudal with two broad oblique bars and the median rays pink, the intermediate colour yellow; the upper and lower edges white.

Described and figured from a specimen 43½ mm. long. Four others 34-44½ mm. long, exhibit but little variation, but show that a sixth dorsal spine may be developed, and there may be only sixteen rays.

Affinities.—This species apparently differs from *P. taeniatus* Regan (Trans. Linn. Soc., Zool., (2), xv., 2, 1912, p. 302) in its colour marking, the dark marking on the tail being undeveloped in that species. Its proportional details also appear to be different.

Locality.—The five specimens referred to above were collected at Bowen, Queensland, by Mr. E. H. Rainford, who found them in a log which was honeycombed by Cobra, *Calobates*, in the empty tunnels of which they were dwelling. He later secured many others at the same locality.

EXPLANATION OF PLATES XXXVII.-XLI.

Plate xxxvii.

Fig. 1. *Carcharhinus macrurus* Ramsay & Ogilby. A female, 877 mm. long, from Botany Bay, New South Wales.
Fig. 2. Under surface of the head of the same specimen.
Fig. 3. Upper and lower teeth of the same specimen.
Fig. 4. A scale from the shoulder of the same specimen.
Fig. 5. *Galeorhinus australis* Macleay. An adult male, 1525 mm. long, from the coast of New South Wales.
Fig. 6. Under surface of the head of the same specimen.
Fig. 7. Upper and lower teeth of the same specimen.

Plate xxxviii.

Fig. 1. *Trygonorrhina fasciata* Muller & Henle. A young specimen, 380 mm. long, from off Sandon Bluff, New South Wales.
Fig. 2. Nasoral region of the same specimen.
Fig. 3. *Hypnarce subnigra* Dumeril. A male specimen, 353 mm. long, from off Cape Hawke, New South Wales, 47-60 fathoms.
Fig. 4. Nasoral region of the same specimen.

Plate xxxix.

Fig. 1. *Dasyatis kuhlii* Muller & Henle. A half grown male, 243 mm. wide, from off Bustard Head, Queensland, 20 fathoms.
Fig. 2. *Dasyatis kuhlii.* A young male, 177 mm. wide, from the same locality.

Plate xl.

Fig. 1. *Dasyatis thetidis* (Ogilby) Waite. A female specimen, 890 mm. wide, from off Norah Head, New South Wales, 20-40 fathoms.
Fig. 2. Nasoral region of the same specimen.
Fig. 3. *Scolopsis temporalis* Cuvier & Valenciennes. A specimen 172 mm. long to the end of the caudal rays, from Palm Islands, Queensland.

Plate xli.

Fig. 1. *Urolophus bucculentus* Macleay. A female specimen 600 mm. wide, from off Botany Bay, New South Wales, 60 fathoms.
Fig. 2. Nasoral region of the same specimen.
Fig. 3. Buccal papillae of the same specimen.
Fig. 4. *Pariglossus rainfordi*, n.sp. Holotype, 43½ mm. long, from Bowen, Queensland.

THE AUSTRALIAN APPLE LEAFHOPPER (*TYPHLOCYBA AUSTRALIS* Frogg.).

By J. G. Myers, F.E.S., Biology Section, N.Z. Dept. of Agriculture.

(*Communicated by Dr. R. J. Tillyard.*)

(Four Text-figures).

In the Agricultural Gazette of New South Wales, Vol. 29, p. 568, 1918, Mr. W. W. Froggatt described a Jassid injurious to apple foliage, under the name of *Empoasca australis*, n. sp. He recognised that the injury his new species inflicted on apple leaves was different from that of the well-known American Apple Leafhopper (*Empoasca mali* Le Baron) which is as yet unknown in Australasia; but he supposed that the Australian species was likewise an *Empoasca*. This is not the case. Both species belong to the very well defined Cicadellid subfamily, the *Eupteryginae* (*Typhlocybinae*, *Typhlocybidae* auctt.) but the venation of the Australian insect shows it to be a true *Typhlocyba* (syn. *Empoa*). These differences may be summed up as follows:—

Wing (hindwing, the forewing being known as the tegmen) with submarginal vein .. .. *Empoasca* Walsh
Wing without submarginal vein .. .. *Typhlocyba* Germar.

This character shows very well in Froggatt's excellent figure (*l.c.*). *Empoasca mali* Le Baron indicates its presence "by the characteristic curling of the terminal foliage. This resembles the contortion caused by an attack of the green apple aphis (*Aphis pomi*) and consists of the incurling of the end and the edges of the leaf with a consequent puckering of the upper surface." This species also causes wilting of early potatoes.

On the other hand, the injury caused by *Typhlocyba australis* Frogg. is very similar to that of its very near relative *T. rosae* Linn. which occasionally attacks apple in North America. The apple leaves become "variegated with yellow spots" which spread to form irregular patches, giving the whole leaf a discoloured appearance and eventually killing it. In contradistinction to *Empoasca*, this species shows no preference for young leaves and shoots but rather for old foliage.

Typhlocyba australis has been introduced into New Zealand where it does considerable damage to apple trees in the orchard districts of Auckland (North Island) and of Nelson (South Island).

The insect is characterised as follows:—

Vertex and *pronotum* bright sulphur yellow; *eyes* usually blackish. *Scutellum* bright yellow, often with deeper yellow patch on each side of base. *Tegmina* of the same bright yellow tint, the *membrane* iridescent and hyaline. Wings hyaline. *Underside* uniform yellow. *Frons* yellow. Vertex approximately twice as broad as medianly long; fore border rounded. Pronotum trapeziform,

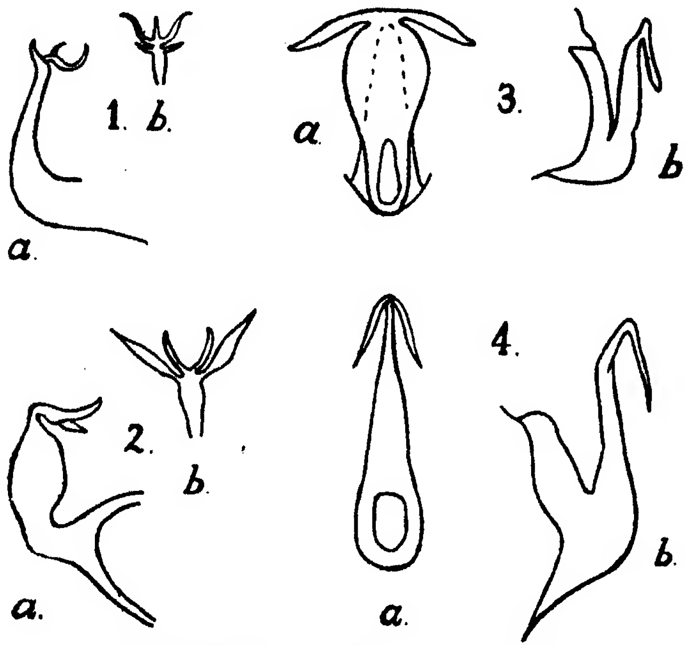
rounded anteriorly and slightly excavated posteriorly. Scutellum slightly narrower at base than base of head including eyes.

Ovipositor shining mahogany brown.

Length (with folded tegmina) 4 mm.

In New Zealand it is found in the Nelson and Auckland fruit districts (November to March), where it inflicts considerable damage on the foliage of apple and hawthorn. The signs of its attack are rusty spots and patches on both sides of young and old leaves, particularly the latter.

Mr. F. Muir, of Honolulu, has very kindly furnished me with drawings of the aedeagus of allied Australian Eupterygines and of the European and N.



(All figures drawn by F. Muir, F.E.S., Honolulu).

Text-fig. 1. *Typhlocyba australis* (Froggatt), paratype, Binalong, N.S.W. *a*, lateral view of aedeagus of male. *b*, apex of ditto.

Text-fig. 2. *Typhlocyba rosae* (Linn.), U.S.A. *a*, lateral view of aedeagus of male. *b*, apex of ditto.

Text-fig. 3. *Erythroneura honiloa* Kirk., Bundaberg, Q. *a*, front view of aedeagus of male. *b*, lateral view of ditto.

Text-fig. 4. *Erythroneura sidnica* Kirk., Sydney, N.S.W. *a*, front view of aedeagus of male. *b*, lateral view of ditto.

American *Typhlocyba* (*Empoa*) *rosae* Linn. As will be readily seen these indicate clearly the points of distinction between the species under discussion and those described by Kirkaldy.

Mr. Muir, to whom specimens were submitted by Dr. R. J. Tillyard, who has kindly placed all notes in my hands, is unable to identify *T. australis* with any American or European species; but he nevertheless considers it possibly an importation into Australia. Until records however are forthcoming of its occurrence in other countries we are justified in considering it distinct. Good figures of the imago, nymph, tegmen, wing and injury to apple foliage are given by Froggatt in his original paper.

THE OCCURRENCE OF OIL DUCTS IN CERTAIN EUCALYPTS AND ANGOPHORAS.

By M. B. Welch, B.Sc., A.I.C., Economic Botanist, Technological Museum.

(Plates xlii.-xlvi., and seven Text-figures.)

The presence, in the leaves, of oil glands or secretory cavities in varying number and mode of distribution, is a characteristic feature of the great majority of Eucalypts and Angophoras, though in several species, particularly in the latter genus, these glands are practically absent. In section these glands appear as ovate, elliptical, or circular cavities which, though varying in size and shape within small limits, are never elongated sufficiently to approach in any way what are known as "ducts," "canals" or "passages." Secretory passages differ from the typical secretory cavities only in their elongation; in origin they are schizogenous, lysigenous or schizolysigenous. They are found in a number of Natural Orders, particularly in the Coniferales, and may occur in the pith, xylem, phloem or cortex. In some genera they are confined to the roots, in others they traverse the whole plant, or are limited to portions of the stem and leaves. Whatever their mode of distribution may be, they possess, without doubt, a marked taxonomic importance and value.

The oil-containing secretory ducts which are described here as being present in certain species of the Eucalypts and Angophoras have apparently not yet been recorded. In fact, Solereder (1908) makes no mention of oil canals occurring in any of the *Myrtaceae*. Macalpine and Remfrey (1891) record, however, the presence of "Central canals," in the petioles of *Eucalyptus calophylla*, *E. ficifolia* and *E. maculata* "with its variety *citriodora*." In that paper the presence of oil is discounted and the contents are classed along with those of the cortical cavities of the petiole as being probably of a kinoid nature. There is no doubt, however, that oil, apparently similar in character to that in the leaf oil-glands, occurs in these canals, and further that tannin substances have not, so far, been found in them.

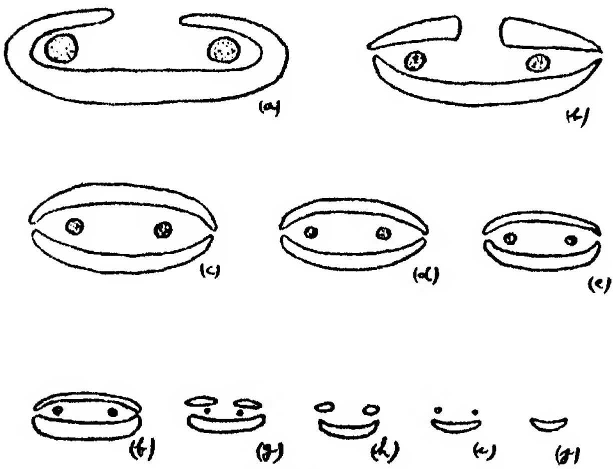
This investigation has shown that ducts occur in the stems and leaves of the following Eucalypts and Angophoras:—*E. Abergiana* F. v. M. (Pl. xliii., fig. 6), *E. calophylla* R. Br. (Pl. xliii., fig. 4), *E. corymbosa* Sm. (Pl. xlii.; Pl. xliv., fig. 5; Pl. xlvi., figs. 1, 5-7), *E. citriodora* Hook. (Pl. xliii., fig. 3), *E. dichromophloia* F. v. M. (Pl. xlv., fig. 1), *E. eximia* Schau. (Pl. xliv., fig. 4), *E. ferruginea* Schau. (Pl. xliv., fig. 1), *E. ficifolia* F. v. M. (Pl. xlvi., fig. 2), *E. Foelscheana* F. v. M. (Pl. xlv., fig. 6), *E. haematoxylon* J. H. M. (Pl. xlv., figs. 2, 3), *E. intermedia* R. T. B. (Pl. xlvi., fig. 4), *E. latifolia* F. v. M. (Pl. xlv., fig. 5),

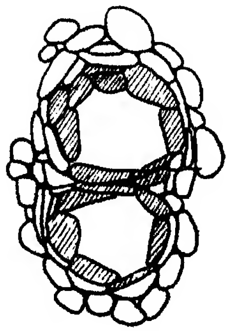
E. maculata Hook. (Pl. xliii., fig. 1), *E. peltata* Benth. (Pl. xliv., fig. 3), *E. pyrophora* Benth. (Pl. xlv., fig. 4), *E. terminalis* F. v. M. (Pl. xliii., fig. 5), *E. trachyphloia* F. v. M. (Pl. xlvi., fig. 3), *E. Watsoniana* F. v. M. (Pl. xliv., fig. 2), *Angophora lanceolata* Cav. (Pl. xliii., fig. 2; Pl. xliv., fig. 6).

E. corymbosa, the common Bloodwood near Sydney, has been selected as being typical of the above species.

In the stems these canals or ducts are usually orientated towards the four corners of the pith, which is more or less rectangular in section, and occur just within the intraxylary phloem, the vascular bundles of the Eucalypts being bicollateral. They are typically four in number, though it is quite common to find fewer, and this number is often exceeded. An example of this is seen in *E. haematoxylon* (Pl. xlv., fig. 3) where nine canals occur. In *Angophora lanceolata* the young stems are usually somewhat triangular (Pl. xliv., fig. 6). This is reflected in the pith and in this species the number of ducts in the stem is commonly three, directed, as in *E. corymbosa*, to the corners. In a large number of Eucalypts now examined (over eighty species) I have found no indication of ducts occurring—when they do occur—in any part of the stem, other than the pith.

In the leaves, the canals are found only in the mid-rib and never in conjunction with any of the lateral or intramarginal veins. In every species of





Text-fig. 2.

Text-fig. 1.—Transverse sections of a leaf nine inches in length, showing the diagrammatic arrangement of the ducts and xylem.

(a) T.S. petiole near stem; (b) T.S. petiole near lamina; (c) 1 inch from base of lamina; (d) 2 inches from base of lamina; (e) 3 inches from base of lamina; (f) 4 inches from base of lamina; (g) 5 inches from base of lamina; (h) 6 inches from base of lamina; (i) 7 inches from base of lamina; (j) 8 inches from base of lamina.

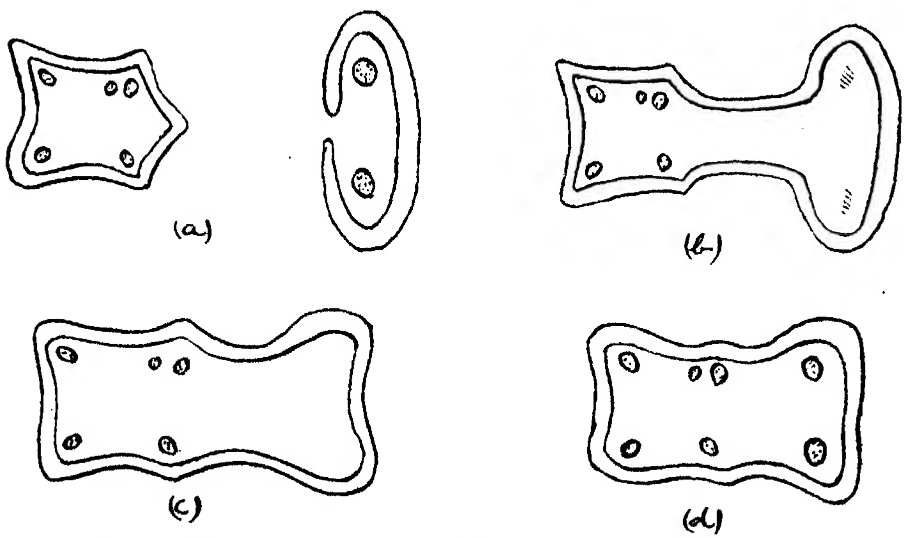
Text-fig. 2.—Two adjacent ducts in a young leaf of *E. corymbosa* which, however, do not show branching. The smaller duct only extends for a very short distance and is independent of the larger one. The shaded cells possess denser contents and are apparently, at this stage, epithelial in character.

Eucalyptus in which these ducts occur, the xylem of the principal leaf-vein forms two distinct, almost parallel, bands along the greater part of its length. This is shown somewhat diagrammatically in Text-fig. 1 (*c.f.*).

In some cases one or both of these zones may be divided into smaller areas (*see* Pl. xliii., fig. 2), but as a rule the equal development of the xylem on both sides is a characteristic of these species. Text-fig. 1 *g* shows the upper zone of xylem divided into two, this section being taken at a point 5 inches from the junction of the petiole and lamina. In this section the ducts are 0.04 mm. in diameter and disappear a very short distance further along the leaf. In the uppermost three inches of the leaf, represented in Text-fig. 1 by the 3 sections *h, i, j,* the ducts are absent, and the two smaller xylem areas also disappear in the last section. The only marked exception to this typical arrangement of the xylem is found in the mid-rib of *Angophora lanceolata* (Pl. xliv., fig. 6). The structure in this species is, however, typical of the vast majority of the Eucalypts examined, but in which ducts are wanting.

There is a gradual diminution in diameter as the canal passes along the petiole and through the lamina of the leaf. Where the petiole joins the stem the ducts are comparatively large, varying up to 0.35 mm. in diameter in *E. eximia.* At the junction of the petiole and leaf blade they are somewhat smaller, and in the leaf are commonly 0.10 mm. in diameter, showing a gradual reduction in size until at a point about 2/3 of the distance from base to apex, they disappear.

Although two is the normal number of ducts in the leaf, it is quite common to find a third or fourth, seldom more. These arise independently alongside the others, in some cases in actual contact (Text-fig. 2), but evidence of branching is rarely found. These secondary ducts do not persist, as a rule, for any distance, and gradually taper off and disappear. In a few cases one of the



Text-fig. 3.—Transverse sections of the junction of the stem and petiole of a mature leaf showing diagrammatic arrangement of the xylem and ducts.

main ducts may disappear, but only for a short distance, reappearing in the same relative position as before. The fact that the two leaf ducts are normally continuous for some distance is shown by the quantity of the exudation from them when cut transversely. This is particularly noticeable in the large

leaves of *Eucalyptus eximia,* where medium-sized droplets appear on the cut surface. There is apparently a break in continuity of the ducts, however, where the petiole joins the stem. Text-fig. 3 *a* shows the arrangement of the xylem in the young stem (left) and petiole (right), and the distribution of the ducts in either case at the junction. In Text-fig. 3 *b* the vascular bundles in stem and petiole have joined up and, although there is no alteration in the number and arrangement of the ducts in the stem, in the petiole the positions of the ducts are marked only by a small quantity of thin-walled parenchymatous tissue with no cavity. In intermediate stages between (*a*) and (*b*) it is found that the cavity gradually becomes smaller, being encroached upon by thin-walled cells. Text-fig. 3 *c* shows that the "petiole" ducts have quite disappeared, although as before, the ducts in the stem show no alteration. In Text-fig. 3 *d*, the two ducts reappear in a corresponding position to that which they occupied in the petiole, and are persistent down the stem. The non-continuity of the ducts is also noticed in the very early stages of development of the leaves, and will be dealt with later.

Seedlings of several of the species were obtained and an examination gave the following results:—

E. citriodora, seedling 18 inches high.—There was no trace of ducts below a distance of six inches from the hypocotyl. About 12 inches from the hypocotyl the ducts were well developed, there being four in the stem and two in the petiole and leaves. In the latter, however, they were only persistent for a comparatively short distance—about 1.5 inches in a leaf 5-6 inches in length.

E. eximia, seedling 24 inches high.—There was no clear evidence of ducts until about 15 inches from the hypocotyl. In some leaves ducts were not found in the lower portion of the petiole, but occurred nearer the leaf blade; in others the ducts were normal in arrangement, two being the usual number.

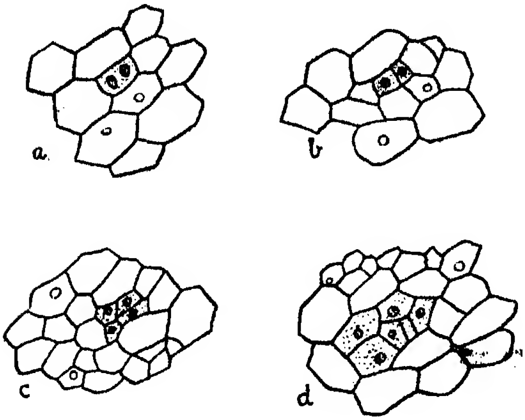
E. trachyphloia, seedlings 4 inches high.—There was no trace of ducts in the lower part of the stem, but a single duct was found in the pith, near the top. A single duct was also observed in the petiole and lower portion of the lamina in several of the leaves, which were linear-lanceolate and about 2 inches in length.

Seedlings of *E. corymbosa* and *E. maculata* were also examined and gave similar results. It is evident that these ducts do not occur in the roots or lower portions of the stem, a number of seedlings being examined in this respect, but with negative results; in both cases the medulla is very small. Sections of the axillary stem nodules in several of the seedlings showed no trace of ducts.

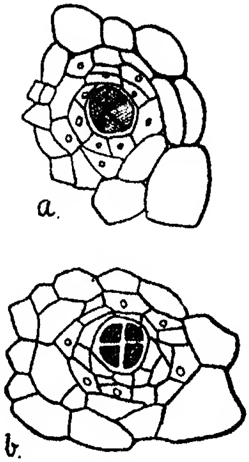
In Plate xlvi., fig. 6 is seen an almost median longitudinal section of a leaf-bud of *E. corymbosa,* with two outer larger leaves, and portions of younger leaves and stem. Two ducts in very early stages of development are present in the larger leaves and on the right are traces of stem ducts. A much enlarged view of portion of one of the outer leaves is shown in Pl. xlvi., fig. 7. The duct is here represented by a row of short cavities, each separated by a distinct end wall. Just above, in the same figure, is a typical gland, showing its relative size and shape. It is apparent that at this stage there is close relationship between an individual cavity of the duct and the oil gland. In older leaves and stems the end walls disappear completely, giving an elongated cavity which varies in length from less than 1 mm. to 100 mm. or more in the leaves, and evidently functions as a *storage reservoir* for the secreted oil. Two elongated cavities or ducts are shown in Plate xlvi., fig. 5, this being an approximately median section, parallel to the leaf surface of *E. corymbosa.* On either side of the primary vein a number of oil glands in the mesophyll are also seen, and it is evident that there is little in common in shape between them and the

ducts. The duct is formed therefore by the linking up of a number of small cavities, each corresponding to a single oil gland, and formed by the division of a single meristematic cell in certain positions in the stems and leaves. Early stages in this development are shown in Text-fig. 4.

Subsequent division causes the formation of a group of cells, characterised by their denser contents, arranged in an almost spherical mass.



Text-fig. 4.



Text-fig. 5.

Text-fig. 4.—Transverse section of a stem apex of *E. corymbosa* showing initial stages in the development of a duct.

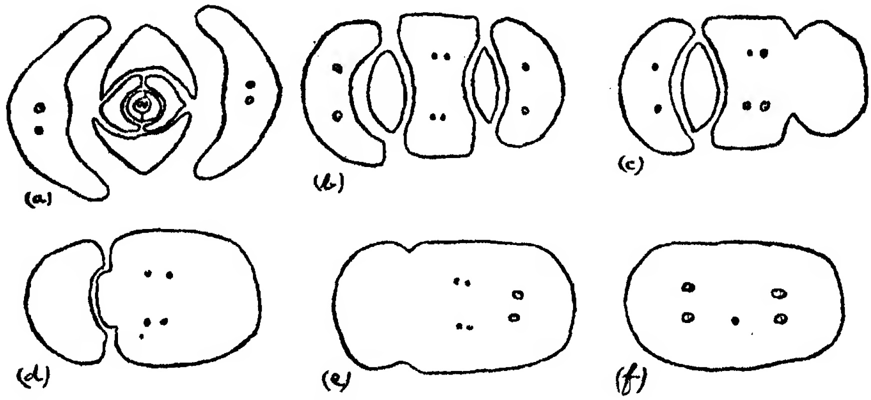
Text-fig. 5.—Later stages in the development of the duct than are shown in Text-fig. 4, but the formation of the central cavity is just commencing.

Separation of these cells then occurs internally, early stages being shown in Text-fig. 5 *a*, *b*, finally leaving a distinct central cavity (Text-fig. 1). There still remains a distinct wall of cells separating each cavity, until, as already mentioned, these barriers break down forming an individual duct. The central cavity has in the meantime enlarged considerably in section, evidently due to natural growth of the surrounding tissues and partly due to disintegration of the inner cellular tissue. Taking into account the mode of their formation, it is evident that these ducts are first formed lysigenously, and later on schizogenously, a mode of formation to which Tschirch applies the term schizolysigenous.

In young leaves there is usually no trace of ducts until they are about 0.75 mm. in width, whereas oil glands appear in leaves with a diameter of less than 0.2 mm. They are never found in the apex of the stem or leaf, e.g. in Pl. xlvi., fig. 6, the larger leaves are about 3 mm. in length and the ducts only extend about 1/3 of the distance from the base. As already pointed out, this is also a characteristic feature in mature leaves.

It is interesting to trace the course of these ducts in the leaf-bud; Text-fig. 6 *a* shows a section through the numerous, almost opposite, leaves towards the apex of the bud of *E. corymbosa*, and, although ducts are well developed in the outer leaves, there is no trace of them yet in the inner ones; Text-fig. 6 *b* is somewhat nearer the base of the bud, and shows a central stem with four very small ducts in very early stages. On either side are the two axillary stems with no ducts, and outside these again are the petioles of the outer

leaves, with two well-developed ducts in each; Text-fig. 6 *c*, still nearer the base, shows the linking up on one side of one of the outer leaves with the stem, and it will be noticed that the ducts on this side have disappeared. In Text-fig. 6 *d* the left hand petiole has almost fused with the stem but, although yet



Text-fig. 6.—Transverse sections of a leaf bud (a) and (b), and stem (e) and (f), with intermediate sections (c) and (d), showing the junction of the almost opposite leaves with the axis, and the arrangement of the central ducts which are not continuous at this point.

distinct, the ducts in this case are also wanting. It will be seen that although almost opposite, the leaves show a tendency to become alternate, a characteristic of the normal growth in this species. Text-fig. 6 *e* shows the complete linking up of both outer leaves with the stem, and the reappearance on the right of two ducts in a position in the stem corresponding to that occupied whilst in the petiole. In Text-fig. 6 *f* the ducts have also reappeared on the left hand side, and it is a striking feature that three of the original stem ducts have disappeared, and the fourth is much reduced in size. This reduction in number of the ducts accounts for the usual appearance of four in the stem, although as already pointed out this number is often exceeded.

The presence of a definite epithelium within the cavity is not always characteristic of these ducts. In many cases an epithelial lining doubtless exists (Text-fig. 1), and in a number of sections the cavity is almost blocked by rows of more or less concentrically arranged thin-walled cells. In other cases, particularly in older stems and leaves, there is no trace of any definite epithelial layer, which probably undergoes disintegration.

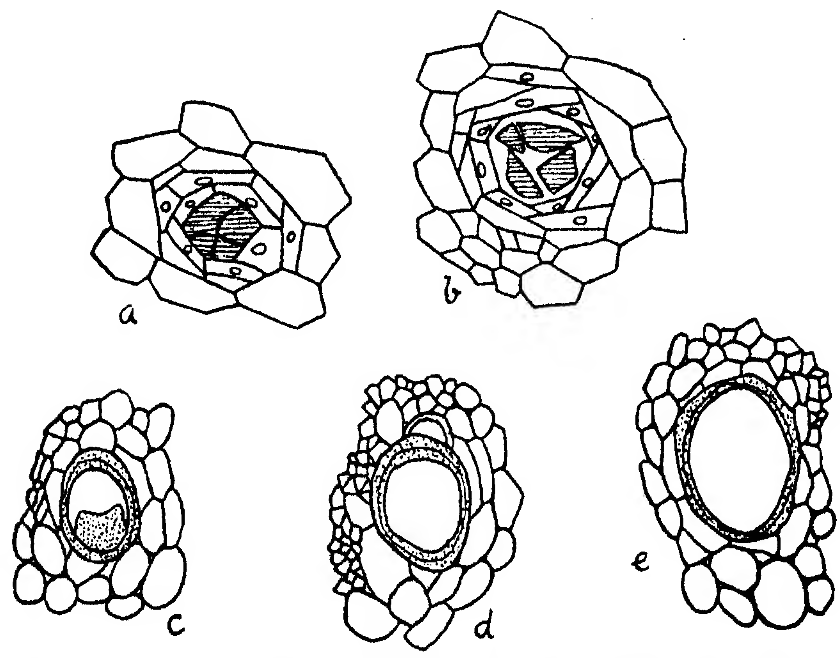
Contents of Secretory Ducts.

In all those species of which fresh material could be obtained the contents of the secretory ducts were examined *in situ*. They were found to be yellowish in colour as a rule, though sometimes almost colourless, and usually granular in appearance under the microscope, owing to a number of small globules being present. Treatment with increasing strength of alcohol had little or no effect until 90% was reached. Here contraction occurred, the contents usually going into final solution in 95-100% alcohol. This solubility of the contents of the duct is in accord with the results obtained for the oil in the mesophyll glands of *E. corymbosa.*

Some of the exudation from a cut stem was transferred to a slide and, as before, solution occurred in 95%-100%, usually in the former. In some cases a very small, clear, film-like residue was left, which was insoluble in chloroform or ether.

Sections of fresh leaves stained in a solution of alkannin in 50% alcohol showed the characteristic bright red colouration in the ducts, indicating the presence of oil. Cyanin in 50% alcohol also gave a positive reaction for oil in the central ducts. Glacial acetic acid, and also aqueous solution of chloral hydrate gave complete solution. The Unverdorben Franchimont reaction (Zimmerman), using copper acetate, showed the normal colouration for terpenes. Tests for tannin gave no indications in the central ducts or in the adjacent cells. There seems no doubt that oil occurs in these central ducts, and is similar, at any rate in behaviour under microchemical tests, to that occurring in the normal glands in the mesophyll of the leaves or in the cortex of stems and petioles.

Some material of *E. corymbosa* was soaked in water for six months and at the end of this period the contents of the ducts were still soluble in 95% alcohol, showing apparently no alteration in this respect. Nevertheless material fixed in "chromacetic acid," picric acid in 50% or 95% alcohol, "formalin



Text-fig. 7.—Ducts in section showing the insoluble residue, (a) and (b) in early stage of development, (c), (d) and (e) later stages in which a lining is found in the cavity.

alcohol" or even ordinary 95% alcohol, shows an insoluble residue, often in the form of a complete ring surrounding the duct when seen in section (Text-fig. 7 *c-e*), or in the cells. It is also noticeable in sections cut from dried leaves. This insoluble residue is sometimes found scattered irregularly in the duct, apparently retaining the outline of the cells in which it was at one time enclosed (Text-fig. 7 *a, b*). It is apparently an oxidation product derived from the

contents of the duct or surrounding cells, and is also found in the oil glands in the leaf. When material is sectioned fresh and transferred direct to 95% alcohol, the ducts and oil glands are found to be free from this residue.

There are certain resemblances or affinities between the species of *Eucalyptus* possessing central ducts. Perhaps the most obvious of these are the "Bloodwood" fruits, more or less urceolate in shape, though the presence of urceolate fruits does not necessarily signify ducts, e.g., *E. Planchoniana*, a "Stringybark" from northern N.S.W., has a very similar fruit to that of *E. calophylla*, the Red Gum of Western Australia, but there is no evidence of ducts in the former species. Another exception is the Tasmanian *E. urnigera*, * with particularly urceolate fruits. Other exceptions are also found. The leaf venation is characteristic; in all species with ducts, the lateral veins are very transverse, in some cases almost at right angles to the midrib, close and numerous, while the intramarginal vein is very near to the edge. *Angophora lanceolata* is also in this class. The converse however does not hold, e.g. *E. saligna*, *E. robusta*, and *E. resinifera*, possess lateral veins which are quite transverse, but no ducts occur. The barks of these species show great variation. The great majority fall into the "Bloodwood" group, the bark being, in some cases, short fibred, friable, and broken, e.g. *E. corymbosa*. Others such as *E. eximia* and *E. terminalis* are more flaky. The greatest exceptions are however *E. maculata*, *E. citriodora* and *Angophora lanceolata*, all possessing typical smooth "Gum" barks.

The majority of *Eucalypts* have isobilateral leaves, in which the palisade mesophyll either extends right across or forms two distinct zones on either side with a narrow zone of spongy mesophyll between, although numerous exceptions occur. Among these species with ducts *E. Abergiana*, *E. calophylla*, *E. corymbosa*, *E. dichromophloia*, *E. ficifolia*, *E. haematoxylon*, *E. intermedia*, together with *Angophora lanceolata*, have a distinctly dorsiventral leaf with the palisade mesophyll developed towards the upper surface only, and stomata present on the lower surface. All the other species mentioned have isobilateral leaves with palisade tissue extending across the leaf and stomata present on either surface. Here again the dorsiventral type of leaf is not peculiar to those specimens with ducts, e.g. *E. resinifera*, *E. robusta*, and *E. saligna* have dorsiventral leaves, but no ducts.

All the species of *Angophora* which have been examined, namely, *A. cordifolia*, *A. intermedia*, *A. subvelutina*, *A. Bakeri* and *A. lanceolata*, also possess the palisade tissue developed only towards the upper surface, but only one species has central ducts.

In those species of *Eucalyptus* with ducts, of which the oils have been investigated by Baker and Smith (1920), the majority fall in their Group 1, i.e. oils consisting largely of pinene without phellandrene. *E. calophylla*, *E. corymbosa*, *E. eximia*, *E. intermedia* and *E. trachyphloia* are members of this group and possess oils with only a trace of cineol. *E. maculata* yields an oil without phellandrene and with the cineol percentage increased to 20. In the oil of *E. citriodora* there is no cineol or phellandrene, the chief constituent being citronellal. These authors state that the oil of *E. terminalis* was not investigated as the number of glands in the leaf was so small. Smith (1914), in a paper on the essential oils of the *Angophoras*, points out the great similarity between the oil of *A. lanceolata* and those obtained from the "Bloodwood" group of Eucalypts.

Cuthbert Hall (1914), on the evidence of cotyledons, places in the Bloodwood or Corymbosa group the following species: *E. calophylla*, *E. perfoliata*, *E. eximia*, *E. corymbosa*, *E. trachyphloia*, *E. citriodora*, *E. maculata*, and *E. intermedia*. With one exception, *E. perfoliata*, in which ducts have not yet

* *E. tesselaris* is also an exception.

been observed, these species contain central ducts. Among the species which he predicted would fall in the same class are *E. Abergiana, E. dichromophloia, E. ferruginea, E. Foelscheana, E. peltata, E. pyrophora, E. terminalis* and *E. Watsoniana.*

Bentham (1866), on anthereal evidence, places in the Corymbosae the majority of the species then described, and now found to possess ducts. The only exception is *E. trachyphloia*, which, though placed in the Micrantherae, was apparently classified on imperfect evidence.

As already mentioned, those species of *Eucalyptus* with ducts possess a mid-rib which, for the greater part of the length of the leaf, has the xylem in two more or less equal zones. Species such as *E. setosa, E. miniata, E. phoenicea, E. perfoliata, E. clavigera* and *E. tesselaris*, however, have a similar vascular bundle in the mid-rib, but so far, in the material examined, ducts have not been found. Except in the case of *E. tesselaris*, however, fresh material was not available.

Geographically these species are distributed through Western Australia, and Northern Territory, extending into Northern South Australia, Queensland, and New South Wales, while one species extends into Victoria. With this exception, species with ducts do not occur in Victoria or Tasmania.

From an evolutionary standpoint, the presence of these ducts in certain species of the Angophoras and Eucalypts adds another argument to the theory of their common ancestry put forward by Baker and Smith. In no other genera of the Tribe *Leptospermeae*, have similar central oil ducts been observed—at any rate in those species worked on—though, as shown, the occurrence of these canals is purely a specific character. The closely allied genus *Tristania*, however, has a well developed lactiferous system in at least one species. It therefore seems probable that the species of *Eucalyptus* with ducts are the oldest members of the genus, and that this character has been entirely lost in the later types, which evolved for the most part smaller fruits, isobilateral leaves and a more oblique leaf venation.

SUMMARY.

Oil ducts, formed by the linking up of a chain of short secretory cavities, corresponding in size and formation to the oil glands in the leaf, occur in the stems and leaves, both normal and abnormal, of certain Eucalypts and Angophoras. So far, they have not been found in any other genera of the Leptospermeae, and their occurrence is purely specific.

There is no direct connection between these central ducts and the leaf, petiole or stem oil glands, though both structures apparently possess an oil of a similar nature. They are not kinoid in character. These ducts are not continuous in stem and leaves, but show a break at the petiole. They are variable in diameter and length, ranging from 0.3 mm. to less than 0.03 mm. in the former and from over 100 mm. to less than 1 mm. in the latter dimension. They apparently function as storage reservoirs.

No evidence has been found so far to show that these ducts occur in the roots and they have not been observed in the lower portions of the stems of seedlings.

The presence of these central canals in a very limited number of Eucalypts, all of the Corymbosae class, indicates their primitive character, and their occurrence also in one species of Angophora, shows apparently a close phylogenetic affinity between the two genera, *Angophora* and *Eucalyptus.*

In conclusion I should like to express my indebtedness to Mr. J. H. Maiden,

I.S.O., F.R.S., for his courtesy in allowing me to obtain material of many of the rarer Eucalypts from the Botanic Gardens. I am also indebted to Mr. R. T. Baker, Professor Lawson and Dr. McLuckie for kindly advice and criticism throughout the work.

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EXPLANATION OF PLATES XLII.-XLVI.

Plate xlii.

E. corymbosa Sm. Transverse section of a portion of a leaf showing typical arrangement of the two central oil ducts in the medulla between the two parallel bicollateral vascular bundles. The almost equal distribution of the xylem in two bands along the greater portion of the leaf is typical of Eucalypts of the Corymbosae group. The palisade tissues are developed towards the upper surface only in this species.

Plate xliii.

Fig. 1. x 55; Fig. 2. x 80; Fig. 3. x 110; Fig. 4. x 60; Fig. 5. x 70; Fig. 6. x 50.

Fig. 1.

E. maculata Hook. Transverse leaf section with two ducts, in which a small dark residue remains. This section was made from dried material. The palisade extends right across the lamina, and stomata occur on either surface.

Fig. 2.

Angophora lanceolata Cav. Transverse leaf section. This is the only genus of the *Myrtaceae*, outside the Eucalypts, in which central oil ducts have so far been found. The xylem of the mid-rib in this species more nearly approaches that found in the majority of Eucalypts, though in some material there was a tendency towards the *E. corymbosa* type. The contents of the ducts (normally two) are light yellow in colour and soluble in 95-100 per cent. alcohol. As in the other Angophoras the palisade tissue is found towards the upper surface only, though this is the only species of the genus in which ducts have so far been observed.

Fig. 3.

E. citriodora Hook. Transverse leaf section. Two ducts are usually found in this species. The palisade tissues extend right across the leaf, and stomata occur on both surfaces.

Fig. 4.

E. calophylla R. Br. Transverse leaf section in which two ducts are present,

though almost completely blocked by a dark insoluble residue. In this case the palisade tissues only occur towards the upper surface. This section was cut from dried material

Fig. 5.

E. terminalis F. v. M. Transverse leaf section with one duct. In some material of this species examined there was no evidence of ducts, which are apparently not well developed in the species. The palisade tissue extends right across the leaf, and stomata occur on either surface.

Fig. 6.

E. Abergiana F. v. M. Transverse leaf section with two ducts. The palisade tissues are developed towards the upper surface only, and stomata occur on the lower side.

Plate xliv.

Figs. 1 and 2. x 45; Fig. 3. x 55; Fig. 4. x 50; Fig. 5. x 13; Fig. 6. x 17.

Fig. 1.

E. ferruginea Schau. Transverse leaf section with two ducts. The palisade tissue consists of long narrow cells and extends right across the leaf; stomata are found on either surface.

Fig. 2.

E. Watsoniana. Transverse leaf section with two small ducts. The palisade tissue extends right across the leaf, and stomata are developed on either surface. The upper xylem band in this section shows a decided break at a point nearer the petiole than is usual.

Fig. 3.

E. peltata Benth. Transverse leaf section with two ducts. The contents are bright yellow in colour and soluble in 90 per cent. alcohol. The palisade extends right across the leaf, and stomata are equally developed on either side.

Fig. 4.

E. eximia Schau. Transverse leaf section with three distinct central ducts, though two are normal. The contents are usually clear, light yellow, soluble in 90-95 per cent. alcohol. In this species a red pigment is often found in the hypodermal cells of the mid-rib. The palisade tissue extends practically right across the leaf, and stomata are on either surface.

Fig. 5.

E. corymbosa Sm. Transverse section of stem showing normal arrangement of four ducts in the corners of the pith.

Fig. 6.

A. lanceolata Cav. Transverse section of young stem showing three oil ducts oriented towards the angles of the pith.

Plate xlv.

Fig. 1. x 50; Figs. 2, 3 and 6. x 30; Fig. 4. x 70; Fig. 5. x 40.

Fig. 1.

E. dichromophloia F. v. M. Transverse leaf section with two small central ducts. In the material examined of this species only one leaf duct was often found with very little contents which were soluble in 90 per cent. alcohol. The palisade tissue is directed towards the upper surface only. In the stems two ducts were usually found, almost filled with thin-walled cellular tissue.

Fig. 2.

E. haematoxylon J. H. M. Transverse leaf section with three central ducts, though two were normal in the material examined. Contents very pale yellow in colour and soluble in 90 per cent. alcohol. The palisade tissue is developed towards the upper surface, and stomata occur only on the lower epidermis.

Fig. 3.

E. haematoxylon J. H. M. Transverse section of stem showing nine ducts, five of which are abnormal. There are also four oil glands present in the cortex.

Fig. 4.

E. pyrophora Benth. Transverse leaf section with two ducts almost completely closed by a dark residue. There are also several phloem cavities as this material was dry when examined. The palisade tissue extends right across the leaf.

Fig. 5.

E. latifolia F. v. M. Transverse leaf section with three ducts, one of which retains a dark residue. Small phloem cavities are seen also in this section, which was made from dried material. The palisade extends right across the leaf, and stomata are developed on either side.

Fig. 6.

E. Foelscheana F. v. M. Transverse leaf section with only one duct, the number usually found in the dried material examined. The numerous large cavities in this section are due to the disintegration of the intraxylary phloem, apparently caused by the pressing during preparation as a herbarium specimen and subsequent softening of the leaf for sectioning. The palisade tissues extend right across the lamina.

Plate xlvi.

Fig. 1. x 30; Figs. 2, 4 and 5. x 50; Fig. 3. x 65; Fig. 6. x 20; Fig. 7. x 155.

Fig. 1.

E. corymbosa Sm. Transverse section of petiole showing two ducts. These are usually larger in diameter than those in the leaf.

Fig. 2.

E. ficifolia F. v. M. Transverse leaf section with two ducts. The contents are usually colourless or very pale yellow, minutely granular, and soluble in 90 per cent. alcohol. The palisade is developed towards the upper surface only, and stomata are found on the lower epidermis.

Fig. 3.

E. trachyphloia F. v. M. Transverse leaf section with two ducts, the contents being usually light yellow and soluble in 95 per cent. alcohol. The palisade shows greater development towards the upper surface, and stomata are found on the lower side only.

Fig. 4.

E. intermedia R. T. B. Transverse leaf section with two comparatively large ducts, containing a small amount of residue; this section being obtained from dried material. The palisade mesophyll consists of one or two rows of cells towards the upper epidermis.

Fig. 5.

E. corymbosa Sm. Median section parallel to the leaf surface with two oil ducts in the mid-rib. On either side are a number of oil glands distributed in the mesophyll of the leaf.

Fig. 6.

E. corymbosa Sm. Median longitudinal section through a leaf bud showing two leaf ducts, and on the right are evidences of two stem ducts. There is no direct connection between these two systems of ducts.

Fig. 7.

E. corymbosa Sm. Portion of one of the leaves in the preceding figure under a greater magnification, showing the "duct" composed of a row of small elongated cavities, corresponding in size and shape to the oil gland seen above. By the breaking down of the transverse walls the passage becomes continuous.

CHEMICAL NOTES.—BOTANICAL.

By Thos. Steel.

I. Analyses of some Australian Fruits.

1. *Eupomatia laurina* R.Br.

This is a tall Laurel-like shrub bearing urceolate, succulent, sub-acid fruits. Ripe fruits were selected from a plant growing in Sydney Botanic Gardens, June 11th, 1897.

2. *Ficus macrophylla* Desf. Moreton Bay Fig.

Largely cultivated for shade and ornamental purposes, bears quantities of purple, globular fruits, about 1 inch in diameter. These are much sought after by the Great Fruit Bat or "Flying Fox" which comes into the cities at night to feed on them. From a tree growing at Petersham near Sydney.

3. The same, from trees in Sydney Domain; in both cases ripe fruit collected in May, 1897.

4 and 5. *Ficus Cunninghamii* Miq. Sydney Botanic Gardens.

Ripe fruit collected May, 1898.

6. *Ficus rubiginosa* Desf.

Unripe fruit from Sydney Botanic Gardens, May, 1898.

7. Edible Fig, purchased in Sydney. For comparison.

8 and 9. *Podocarpus elata* R.Br.

The fleshy fruit-stalks which carry the hard nut-like fruit on top and have given rise to popular statements about Australian cherries with the seed outside. The entire fruit is swallowed by birds, the soft stalks being digested and the hard seed dropped wherever the bird chances to go, thus insuring distribution. The fleshy stalks were separated, pulped and analysed. Of the entire fruit, 47.7 per cent. was stalk and 52.3 seed. The average weight of one stalk was 1.3 gram. Cane sugar was absent, the sugars present being the usual constituents of Fruit sugar, dextrose and levulose. Collected June, 1897, two samples. The pulped fruit-stalks have a fine rich purple colour, soluble in water or spirit, and yielding a brilliant claret-coloured liquid which turns blue with alkalies.

The method used in analysing these fruits is described under "Fijian Wild Sugar Cane" below.

	1	2	3	4	5	6	7	8	9
Dextrose	2.05	5.75	6.77	4.07	3.30	{ 0.30	5.65	2.56	2.00
Levulose	1.70	4.84	5.69	2.97	2.98		4.07	2.59	1.94
Seeds, fibre, pectose, &c. .	17.98	20.24	19.88	8.89	10.50	24.37	3.34	39.20	40.65
Ash	1.42	1.90	1.64	1.11	0.97	2.30	0.44	0.84	0.41
Water	76.85	67.27	66.02	82.96	82.25	73.03	86.50	54.81	55.00
	100.00	100.00	100.00	100.0	100.00	100.00	100.00	100.00	100.0
Nitrogen				0.16		0.29	0.25		

1, *Eupomatia laurina.*
2, 3. *Ficus macrophylla.*
4, 5. *F. Cunninghamii.*
6. *Ficus rubiginosa* (unripe).
7. Edible fig.
8, 9. *Podocarpus elata* (Fruit stalks).

II. Fijian Wild Sugar Cane.

The banks of the fresh water rivers of Fiji are covered with a dense tangled growth of a long slender cane. It is called Vico (Pronounced Vitho in Fijian) by the Fijians but, so far as I know, no use is made of it. There are two varieties, red and yellow. Mr. E. Cheel who examined it in Fiji informs me that botanically he considers it to be a variety of *Saccharum officinarum*, the common sugar cane.

In November, 1885, when the cane was ripe, I made analyses of four samples. For purposes of comparison I give an analysis, made at the same date, of native cane cultivated by the Fijians and known as Anani, also one of a representative sample of introduced cane of the variety named "Honolulu," at that time largely grown in Fiji for the supply of the sugar mills. The native cane, Anani, is apparently indigenous; at any rate it is the variety grown by the natives for a very long time past, before the advent of Europeans. At the time of my residence in Fiji, about 1885-1886, it was preferred by the Fijians for food purposes to any of the introduced varieties, although these were sweeter. This was probably because they had always used it and were accustomed to it. The method of use was to grate the cane to pulp on a piece of rough coral and squeeze out the juice, which was then used for sweetening purposes.

The analyses are as follows:—

		Fijian Wild Cane				Sugar Canes.	
		Red.		Yellow.		'Anani'	'Honolulu'
Soluble in water	Cane Sugar	3.33	1.68	3.16	3.27	10.88	15.08
	Fruit Sugar	1.00	1.68	.97	.74	.52	.61
	Other organic matter	1.37	1.56	1.71	1.58	1.73	.80
	Ash	1.35	1.08	1.39	1.11	.26	.17
Insoluble	Fibre	22.48	18.46	26.15	27.08	15.54	11.98
	Ash	.24	.22	.35	.44	.36	.32
	Water	70.89	75.80	66.80	66.38	71.52	70.52
		100.66	100.48	100.53	100.60	100.81	99.48
Average weight per stalk. Kilog. ..		0.38	0.61	0.45	0.51	—	1.51

The Fruit sugar in these canes consists of about equal proportions of dextrose and levulose.

The method of analysis followed was that of diffusion. In preparing the sample of cane for analysis the stalks were quartered lengthwise and one complete section from each stalk was chopped into short lengths which were pulped by passing through a meat mincing machine, the pulp so obtained being well mixed and the requisite quantities quickly weighed off. A known weight of pulped cane was put into a tared flask with sufficient water, the flask, fitted with a cork and a plain long tube as a return condenser, was placed in a vessel of boiling water and shaken at frequent intervals for one hour. The flask and contents were then cooled and weighed and the amount of added water thus ascertained. The liquid was then strained off through a fine cotton cloth and analysed. The percentage of fibre and water in the original pulp having been determined and the Sp. Gr. of the diffusion liquid ascertained, the total weight of liquid derived from added water and that in the pulp taken is thus readily found. The liquid being analysed, it is a simple matter to calculate the total constituents present and to compute therefrom the percentages in the original pulp. 200 grammes pulp and about 400 of water are convenient quantities to use.

In examining the fruits mentioned above, they were passed direct through the meat mincing machine and the diffusion conducted as for cane. 200 grammes pulped fruit and 300 to 350 of water proved suitable proportions. In fruits the direct determination of matter insoluble in water is not always practicable owing to the glutinous nature of the pulp and the imperfect solubility of the pectin bodies. In these, therefore, the total of these constituents was taken by difference which is sufficient for all essential purposes.

III. Roots of Dragon Tree, *Cordyline terminalis*.

In Fiji the long conical roots of the Dragon tree (*Cordyline terminalis*) known by the natives as Vasili dinu (Pronounced ndinu in Fijian) and Vasili tagu (Pronounced tangu in Fijian), are, after roasting, used as food. Prior to cooking, the roots are white and contain a large proportion of inulin which during the process of roasting becomes transformed into the sugar levulose. After roasting, the roots are soft, succulent and black, looking as if they had been soaked in molasses. The dark colour is due to caramelisation of part of the levulose.

		Raw		Roasted 1	Roasted 2
Soluble in Water	Levulose	3.32	Levulose	38.53	40.49
	Inulin, &c.	30.19	Caramel, &c.	10.85	6.93
	Ash	.27	Ash	.58	.58
Insoluble	Fibre	11.59	Fibre	12.58	14.06
	Ash	.59	Ash	.42	.68
	Water	52.98	Water	38.00	38.64
		98.94		100.96	101.38
Weight of root. Kilogs.		1.64		2.08	1.30

It will be noticed that the raw root was found to contain a small proportion of levulose, it also contained numerous raphides but no starch.

Dr. George Bennett (Gatherings of a Naturalist, 1840, p. 397) states that the root of the Ti (*Dracaena terminalis*) contains a large quantity of saccharine matter, from which the natives of Tahiti extract a coarse sugar; they likewise bake and eat the root, from which also a spirituous liquor is distilled. As will be seen from the analyses above the sugar is only present after cooking.

Speaking of the same root, H. S. Cooper (Coral Lands. Vol. ii., 1880, p. 170) says:—"In the Friendly Islands, as well as in all the other neighbouring groups, great quantities of the *ti* or dragon-tree are found. The root when cooked contains a most extraordinary quantity of saccharine matter; indeed it seems as if it had been boiled in syrup. Rum is distilled from it in the Friendly Islands as well as from the sugar cane."

IV. Deposit of Calcium carbonate in Timber of Geissois Benthami (F. v. M.)

Some time ago I received from Mr. Maiden a specimen of timber of Red Carrabeen, *Geissois* (*Weinmannia*) *Benthami* (F. v. M.), coated in places with a rather hard flinty-looking mineral deposit. This is referred to by Mr. Maiden (Forest Flora of N.S. Wales, VI., 1917, p. 208) as being a source of trouble to saw-millers in the Dorrigo (N.S. Wales), where it is known as "flint." It occurs in the heart of the logs and causes injury to the saws. The suggestion is made that the deposit may be siliceous. Chemical examination showed that it consists of pure calcium carbonate. The amount of deposit at my disposal was insufficient to allow of a quantitative analysis, but qualitative tests disclosed

no other substance present. A few chips of the timber carrying the deposit, and of the same, in so far as could be seen, quite free therefrom, were submitted to analysis:—

Timber of *Geissois Benthami* (Air-dry).

	Incrusted portion	Free from visible incrustation
Ash (CO_2 free)	11.4	0.97
Lime (CaO)	10.2	0.31
equal to Calcic carbonate	18.2	0.55
Water	—	9.6

I have not noticed any previous record of the occurrence of this substance in a timber, though its existence as crystoliths in the bark of *Ficus* and some other plants has been noted (H. G. Smith, Journ. Royal Soc. N.S. Wales, xxxix., 1905, p. 29).

V. The Nitrogen Content of Fungi.

In June and July, 1897, I examined a number of Australian fungi for nitrogen. Three of these were freshly collected on the Blue Mountains, N.S. Wales and identified by Mr. R. T. Baker; others were ordinary dried herbarium specimens from the collections in the Technological Museum, Sydney, given to me by Mr. Baker. The *Polyporus mylittae* C. et M. (*Mylitta australis* Berk.), popularly known as "Blackfellow's bread," was collected at Wentworth Falls, N.S. Wales, and consisted of a sclerote weighing 2416 grams. The results obtained are as follows:—

Percentage of nitrogen in Australian fungi (dry).

Peziza fasciculosa	6.86
Stereum caperatum	1.83
„ *lobatum*	2.40
Polyporus mylittae	0.51
„ *portentosus*	2.47
Hexagona subtenuis	1.16
„ sp.	2.16
Lenzites repandra	1.12
Polystictus flabelliformis	0.70
„ *sanguineus*	2.40
Trametes Muelleri	0.52
„ *lactinea*	2.21
Clathrus cibarius	1.99
Xylostroma giganteum	0.30

X. giganteum really consists of the sterile mycelium of several Polyporaceae, chiefly *P. eucalyptorum* and a species of *Fomes*.

The three fresh specimens, as under, contained respectively of water:—

	% Water
Peziza fasciculosa	95.9
Clathrus cibarius	93.5
Polyporus mylittae	77.2

The moisture in the herbarium specimens varied from 10 to 15 per cent. *P. mylittae* in its fresh state yielded 0.15 per cent. ash.

In a paper on *P. mylittae* by Mr. J. H. Maiden (Agric. Gaz. N.S. Wales, iv., 1893, p. 909) it is stated to contain no nitrogen in any form. The specimen

examined by me certainly contained nitrogen, though by comparison with some of the other fungi the amount is not high.

The method used for the nitrogen determinations was the Kjeldahl-Gunning.

VI. Exudation from *Myoporum platycarpum* R.Br.

In January, 1921, there was forwarded to Sydney Botanic Gardens a sample of a dark brown sugary-looking mass which had been found by Mr. P. Webb in a hollow trunk of the above tree at Barton, S. Australia. This was kindly handed to me by Mr. Maiden for investigation. Examination showed it to consist of impure mannitol from which the pure substance could be readily obtained by extraction with hot alcohol, the mannitol crystallising out on cooling.

A similar exudation from a tree of the same species was obtained during the Elder Exploring Expedition to Central Australia. This was analysed by Mr. H. G. Smith and the results published by Mr. Maiden (Trans. Royal Socy., S. Aust., xvi., 1892, p. 1).

For the analysis of the Barton sample I am indebted to my colleague Mr. E. F. Vaughan. For purposes of comparison I have placed the figures of both analyses together:—

	Elder Expedition. Central Australia.	Barton. South Australia.
Mannitol	89.65	44.0
Reducing sugar	2.87	5.4
Other sugars	0.51	—
Gums, insoluble, &c.	2.37	40.8
Ash	1.10	1.9
Water	3.50	7.9
	100.00	100.0

The exudation is known to occur from punctures made by insects.

The Barton sample resembled lumps of coarse raw cane sugar and contained somewhere about 10 % of insoluble matter, principally vegetable debris. It had evidently undergone some deterioration. Barton is a station on the East-West Railway Line crossing the Australian desert.

NOTES ON NEMATODES OF THE GENUS *PHYSALOPTERA*, WITH SPECIAL REFERENCE TO THOSE PARASITIC IN REPTILES.

Part i.

By Vera A. Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

The genus *Physaloptera* was established by Rudolphi in 1819, to include five species separated from the genus *Spiroptera*. It is characterised by the presence of two lateral lips armed with teeth at the extremity, and, in the male, a closed lanceolate bursa, embracing the base of the tail and bearing four pairs of pedunculated papillae, in addition to a variable number of other papillae.

Two monographs have been published on it, both in Italian, one by Molin in 1860, and the second by Stossich in 1889. Rudolphi in his original diagnosis, had shown some doubt about his classification ("Alias enim artificiosum esse facile concedo", Entoz. Synop., p. 236), and, in consequence of this, Dujardin, in 1845, suppressed the new genus, and reunited all its species, provisionally, with the genus *Spiroptera*, "en attendant que toutes les espèces soient suffisamment connues pour qu'on puisse établir, d'après leur organisation plusieurs coupes génériques" (Hist. nat. d.'Helm., p. 83). Its definite reestablishment is due to Diesing who published a well-defined diagnosis in 1851, and repeated it, with some slight additions, in 1857 (p. 16). In his "Revision der Nematoden," published in 1860, after the appearance of Molin's monograph, he gave a further amended diagnosis:—"Corpus elongatum teretiusculum. Caput corpore continuum, bilabiatum, labiis externe papillis exornatis, interne dentibus armatis. Os ad basin labiorum. Extremitas caudalis maris utrinque alata, alis inflatis antice vesica conjunctis, ad aperturam genitalem quadricostatis. Penis vagina monopetala. Apertura genitalis feminea in anteriore corporis parte; uterus bicornis. Ovipara. Mammalium, Avium et praecipue Amphibiorum: in oesophago et ventriculo, rarius in intestinis, rarissime in cavo orbitae endoparasita." Since that date the validity of the genus has never been questioned, Schneider rightly remarking (1866, p. 59) that *Physaloptera* is one of the best of Rudolphi's genera.

Diesing used the term "Amphibiorum" in the original Linnean sense, which did not distinguish between Amphibia and Reptilia. None of the species known at that time had been found in Amphibia, and, with a single exception, all the species recorded up to the present have been found in the higher Vertebrates, carnivorous species of mammals, birds and reptiles. They are almost invariably found in the alimentary canal.

Statistics given by the early helminthologists show what was known, at the time of writing, of the distribution of the species among the various hosts. It is summarised here in tabulated form.

Author	Total number of known spp of hosts.	Distribution.		
Rudolphi (1819) ...	7	1 mammal	4 birds	2 reptiles
Diesing (1851)	53	12 „	32 „	9 „
Molin (1860)	73	22 „	21 „	30 „
Stossich (1889)	104	27 „	40 „	37 „

Molin states that of the 73 hosts which he recorded, only eight were European, the remaining sixty five being exotic, the majority of them American. Twenty nine years later, Stossich gives the distribution of recorded species of Physaloptera as 7 in Europe, 4 in Asia, 1 in Africa, and 28 in America.

Diesing in 1851 had included 13 species in the genus, four of which he regarded as doubtful; Molin enumerated 22, after excluding four of Diesing's species, and including four doubtful ones; Linstow (1878) recorded 31 species, and Stossich (1889) 37, eleven of them doubtful. Of these thirty seven, 15 were found in mammals, 11 in birds, and 11 in reptiles. Between 1889 and 1906 eighteen new species were catalogued in the Zoological Record. This brought the total number of recorded species up to 55, of which 25 occurred in mammals, 14 in birds, 15 in reptiles, and 1 in an amphibian. This number, of course, includes doubtful species. Linstow at this date (1906) gives the number as 20 in mammals, 12 in birds, and 14 in reptiles. Twenty one new species appear in the Zoological Record between 1906 and 1918, and the total number of specific names recorded altogether, up to the end of 1918 is seventy seven, 34 in mammals, 18 in birds, 24 in reptiles, and 1 in a frog. The complete list is given on p. 494, with dates of those species which were proposed as new after the appearance of Stossich's monograph.

On the species parasitic in Reptiles.

Of Rudolphi's original species, two, *P. abbreviata* and *P. retusa,* were found in reptiles, both of them in lizards, and until the appearance of Diesing's Syst. Helm. in 1851, these were still the only species known from this class. Diesing described as a third species, *P. mucronata,* from the alligator, and placed Rudolphi's *Strongylus colubri* in the same genus, among the "species inquirendae," but Molin considered *P. mucronata* to be an Ascarid, and subsequent writers follow him in excluding it from the list of *Physaloptera.* In 1882, Drasche examined and published a revision of the types of Diesing's and Molin's species, and pronounced *P. mucronata* to be a synonym of *Ascaris lanceolata* Molin; but he included *P. colubri* as a valid species. Three other of the early species, all Leidy's, *P. abjecta, P. constricta,* and *P. contorta,* are insufficiently characterised, and are regarded by both Molin and Stossich as doubtful species. Of the other species which make up the list of eleven recorded by Stossich, two were added by Molin, one, *P. spiralis,* by Schneider in 1866, and two, *P. dentata,* and *P. striata,* by Linstow in 1883.

The number of species recorded from reptiles has been more than doubled since that time, but no complete review of the whole group has been published since the date of Stossich's monograph. The amount of work now involved in the search through scattered literature before any systematic work can be undertaken, makes such a review urgently necessary.

Although *Physaloptera* has been met with fairly frequently in Australian reptiles, and is known to be widely distributed, only two definite specific records

have been contributed to Australian reptilian helminthology. Linstow, in 1899, described as a new species *P. antarctica*, from a lizard and a snake in South Australia; and Stossich, in 1902, *P. alba*, from *Cyclodus boddaertii*, "Nuova Olanda." It is curious to find this century-old name used as late as 1902, but a reference to the literature relating to the host affords some explanation of it. In the original description, in 1839, Duméril says "Le Cyclode de Boddaert habit la Nouvelle Hollande, et à ce qu'il parait aussi l'ile de Java, car nous en avons recu du musée de Leyde un exemplaire portant l'indication qu'il provenait des recoltes faites dans cette ile par Kuhl et Van Hasselt." These lizards from Java and Australia are now recognised as two distinct species, viz.:—*Tiliqua gigas* and *Tiliqua scincoides*. As the locality for the Nematodes is given as New Holland, it seems probable that the host from which they were taken was one of Duméril's specimens from Australia, not from Java, i.e., that it was *Tiliqua scincoides*, though Stossich himself does not give any explanation of the record.

Distribution of Physaloptera species.

IN MAMMALS.

anomala Molin
brevivaginata Seurat, 1917
brevispiculum Linstow, 1906.
caucasia Linstow, 1902
cesticillata
circularis Linstow, 1897
clausa Rudolphi
coelebs Linstow, 1897
digitata Schneider
dilatata Rudolphi
elegantissima Stossich, 1902
gemina Linstow, 1899
getula Seurat, 1917
incurva Linstow, 1908
inermis Linstow, 1906
limbata Leidy
magnipapilla Molin
maxillaris Molin
mordens Leiper, 1907
muris brasiliensis Diesing
nasilionis Gedoelst, 1917
numidica Seurat, 1917
papilloradiata Linstow, 1899
papillotruncata Molin
pyramidalis Linstow
ruwenzori Parona, 1907
semilanceolata Molin
sciuri Parona, 1898
spirula Hempr.
tacupensis Seurat, 1917.
terdentata Molin
torquata Leidy
tumefaciens Henry & Blañc, 1912
turgida Rudolphi

IN BIRDS.

acuticauda Molin
alata Rudolphi
„ var. *chevreuxi* Seurat, 1915
„ var. *nouveli* Seurat, 1915
bilabiata Creplin
brevicauda Linstow 1909
bulbosa Linstow, 1906
crassa Linstow
crosi Seurat, 1915
fusiformis Linstow, 1902
galinieri Seurat, 1915
inflata Molin
malleus Linstow
ovata Linstow, 1907
rotundata Linstow, 1906
saginata Rudolphi
striata Linstow
strongylina Rudolphi
tenuicollis Rudolphi
truncata Schneider

IN AMPHIBIA.
(*Rana macrodon*)

amphibia Linstow, 1899

IN REPTILES.

abbreviata Rudolphi
abjecta Leidy
affinis Gedoelst, 1916
alba Stossich, 1902
aloisii-sabaudiae Parona, 1907
antarctica Linstow, 1899
britanica Skrjabin
chamaeleontis Gedoelst, 1916
colubri Rudolphi
constricta Leidy
contorta Leidy
dentata Linstow
leptosoma Seurat (Gervais), 1917
monodons Molin
mucronata Diesing
obtusissima Molin
pallaryi Seurat, 1917
paradoxa Linstow, 1908
quadrovaria Leiper, 1908
retusa Rudolphi
sonsinoi Linstow, 1895
spiralis Schneider
striata Linstow
varani Parona, 1890.

Krefft had already, in 1871, mentioned the occurrence of a *Physaloptera* sp. in *Cyclodus* (*Tiliqua*) *gigas,* but did not describe or name it. T. H. Johnston, taking the Australasian zoogeographical region in its wider sense, to include the East Indies, included Krefft's record in his "Census of Australian Reptilian Entozoa" (1912), and also three species collected by Dr. Willey in the Western Pacific Isles, and identified by Shipley (1900) as *Physaloptera obtusissima, P. retusa,* and *P. varani.* The two former were found in the intestine of a snake, *Dipsadomorphus irregularis,* the latter in the stomach of *Varanus indicus.* It was described originally from specimens taken from the stomach of *Varanus bengalensis* at Palon, Pegu, in South Burma, but has since proved to be widely distributed, extending as far as Northern Africa; and Johnston has indicated its probable occurrence on the mainland of Australia. In 1909 he wrote "I have seen *Varanus indicus* near Gladstone in Queensland, and hence it may be expected that before long . . . *Physaloptera varani* . . . may be added to our known Australasian entozoan fauna." In the same paper (1909*a*) he records "a few specimens of a Nematode, *Physaloptera* sp., perhaps *P. varani* Parona" as found, in addition to a Cestode, in the stomach of *Varanus varius,* the common tree "goanna," obtained near Bathurst, N.S.W.; and later (1912*a*) records the same species from *Varanus gouldii,* the sand "goanna," collected in Queensland. Western Australia, Victoria, and New South Wales, and from *Varanus bellii* collected at Eidsvold, Burnett River, Queensland (1912*b*). In the Census of Endoparasites in Queensland (1916) the same species is again referred to as found in these three species of *Varanus.*

These records are not accompanied by figures or descriptions, and in every case they are queried, Dr. Johnston stating that he had not yet seen a description of *P. varani,* and consequently could not identify it with certainty.

All the other Australian records consist of the mere mention of unidentified species of *Physaloptera* found in various hosts of the orders Lacertilia and Ophidia. They relate chiefly to a series of exhibits made by Dr. Johnston in 1909 and 1910, before the Royal Society of N.S.W., and this Society, of specimens taken from the brown snake, tiger snake, and whip snake, and from the blue-tongued lizard (*Tiliqua scincoides*), tree goanna, slow worm (*Lialis burtonii*) and *Lygosoma* (*Hinulia*) *tenue,* all from New South Wales. There is, in addition, another record by Krefft (1871) of a *Physaloptera* sp. from *Diemenia reticulata.* He does not give the locality from which they were taken, but according to Dr. Johnston, who says he had inspected Krefft's material, and similar specimens collected by Dr. Cleland in the North West, the parasites from this "spinifex snake" came from Western Australia.

From the above records, it will be seen that, up to the present time, representatives of the genus in Australia have been recorded, in Ophidia, from three species of *Diemenia,* and from one species each of *Acanthophis, Dipsadomorphus* and *Notechis;* and, in Lacertilia, from four species of *Varanus,* three species of *Tiliqua,* and one species each of *Lygosoma* and *Lialis.*

But the vagueness of the records is evidence of the difficulty experienced by workers in getting access to the literature which would make specific identifications possible.

In the collection of parasitic Helminths made for the Bureau of Microbiology of New South Wales by Dr. J. B. Cleland over a period of ten years, there are numerous Nematodes from our native fauna. Through the kindness of Dr. Cleland I have had the opportunity of examining that part of it taken from reptiles, and find it to consist in large proportion of *Physaloptera.* The labels on the phials indicate that the hosts among Lacertilia were *Lialis burtonii,*

Gymnodactylus laturus, Varanus sp., and *Hinulia* sp.; and among Ophidia, "black snake" (5 collections), "whip snake" (2 collections) "brown snake" (1 collection), and "snake, Flinders Is." (2 collections). None of these collections of *Physaloptera* has been recorded hitherto, and all the specimens still await identification.

The present work was undertaken with the intention of making a report on them, and on various specimens which have from time to time been brought under my notice from dissections of reptiles in the Zoology Department of the Sydney University. But while endeavouring to gather together the scattered and fragmentary descriptions of known species, it has seemed to me that the information so collected should be made more readily available to workers than it has been hitherto, and that a brief general survey of the *Physaloptera* of reptiles would be useful.

With this end in view, I have compiled a systematic index of all the known reptilian hosts, with the species parasitic in each, grouped under the different orders of reptiles in which they have been found. Every recorded species of the parasites has been included, whether the original description is well defined or doubtful, and without regard to the question of synonymy. These matters will be dealt with later, when the groups are considered in detail. But the hosts have been recorded, as far as possible, under the names accepted in the British Museum Catalogue of Reptiles (1885-1896), since many of the early synonyms, under which the hosts appear in the original records are not readily recognisable, and are difficult to trace. However, those names which it is impossible to identify now are given in the original form, though they must be regarded as *nomina nuda*. This is the case with many of the hosts enumerated by Molin, including most of Fitzinger's species.

The bibliographical catalogue, which follows the host list, is as full as it is possible to make it with the literature available to me; but many of the scientific periodicals required are not possessed by our libraries, so the catalogue must necessarily be regarded as incomplete.

As the new genus *Thubunaea*, which was established by Seurat in 1914, is very closely related to *Physaloptera*, I have added it to the catalogue. The single species, *Thubunaea pudica*, is a reptilian parasite, being found in the stomach of a Chamaeleon, and in two snakes, *Cerastes vipara* L. and *Scincus officinalis* Laur., in Northern Africa.

Host list for Physaloptera *parasitic in Reptiles.*

CHELONIA.

P. contorta.	*Chrysemys reticulata* Daud., *Chrysemys scripta* Shoepff., *Cistudo carolina* Linn., *Cinosternum pennsylvannicum* Wagl.
P. sp.	*Emys venusta* Gray.

CROCODILIA.

P. mucronata.	*Alligator missisipiensis* Gray, *Caiman niger* Spix.

OPHIDIA.

P. abbreviata.	*Tropidonotus tessellatus* Laur., *Ciconia alba* (pseudo parasite, swallowed with reptiles).
P. abjecta.	*Zamensis flagelliformis* Laur.
P. affinis.	*Psammophis sibilans* Linn.
P. antarctica.	*Acanthophis antarcticus* Shaw.
P. colubri.	*Coronella austriaca* Laur.

P. constricta.	*Tropidonotus fasciatus* Linn.
P. dentata.	*Vipera berus* Linn.
P. monodons.	*Boa constrictor* Linn.
P. obtusissima.	*Dipsadomorphus irregularis* Merrem, *Erythrolamprus aesculapii* Linn., *Lachesis lanceolatus* Lacep., *Oxyrhopus cloelia* Daud., *Spilotes pullatus* Linn., *Xenodon severus* Linn., ? *Lygophis regius* Fitz., ? *Ophis coeruleus* Fitz., ? *Ophis rhodogaster* Fitz., ? *Ophis treuensteinii* Fitz., ? *Oxyrhopus fasciatus* Fitz., ? *Pseudophis cinerascens* Fitz.
P. paradoxa (larva).	*Bitis cornutus* Daud.
P. retusa.	*Dipsadomorphus irregularis* Merrem.
P. striata.	*Tropidonotus tessellatus* Laur., *Ciconia alba* (pseudo parasite, probably taken in with reptile food).
P. sp.	*Demansia* (or *Diemenia*) *reticulata* Gray.
P. sp.	*Demansia* „ „ *psammophis* Schl.
P. sp.	*Demansia* „ „ *textilis* Dum. & Bibr.
P. sp.	*Notechis scutatus* Peters.
P. sp.	"un ofidio" Monte Carin, Cobapo. (Parona 1890).
P. sp.	"A large snake" Bismark Archipelago. (Linstow 1897).

LACERTILIA.

P. abbreviata.	*Lacerta agilis* Linn., *Lacerta muralis* Laur., *Lacerta ocellata* Daud., *Lacerta viridis* Daud., *Lacerta vivipara* Jacq., *Ophisaurus apus* Pall. (*syn.* Pseudopus pallasii Cuv.), *Phrynocephalus helioscopus* Gray, *Phrynosome regale* Girard, ? *Chrysolamprus ocellatus* Fitz., ? *Lacerta margaritacea* Spix., ? *Phrynosoma hernandesii* Gray (Phrynosoma douglassi Gray ?).
P. alba.	*Cyclodus boddaertii* Dum. & Bibr. (Tiliqua scincoides or Tiliqua gigas).
P. aloisii-sabaudiae.	*Agama atricollis* Smith.
P. antarctica.	*Tiliqua occipitalis* Gray.
P. chamaeleontis.	*Chamaeleon gracilis* Hallowell.
P. dentata.	*Agama sanguinolenta* Pallas, *Phrynocephalus mystaceus* Pallas, *Agama mutabilis* Merrem (?).
P. leptosoma.	*Uromastix acanthinurus* Bell, *Varanus griseus* Daud.
P. pallaryi.	*Agama bibronii* Dumeril.
P. paradoxa.	*Varanus griseus* Daud., "A Chamaeleon."
P. quadrovaria.	*Varanus niloticus* Gray.
P. retusa.	*Ameiva surinamensis* Laur., *Amphisbaena alba* Lin., *Ophiodes striatus* Strix., *Pygodactylus gronovii* Merr., *Scleroporus undulatus* Merr., *Tropidolepideura* sp., *Tropidurus torquatus* Neu., *Tupinambis nigropunctatus* Spix., *Tupinambis teguixin* Lin., ? *Euprepis spixii* Fitz., ? *Podinema scripta* Fitz., ? *Podinema graphica* Fitz.
P. sonsinoi.	*Agama mutabilis* Merrem.
P. spiralis.	*Amphisbaena* sp.
P. varani.	*Varanus bengalensis* Daud., *V. griseus* Daud., *V. indicus* Daud., *V. bellii* D. & B. (?), *V. gouldii* Gray (?), *V. varius* Shaw (?).
P. sp.	*Lialis burtonii* Gray.
P. sp.	*Lygosoma* (*Hinulia*) *tenue* Gray.
P. sp.	*Tiliqua scincoides* White.
P. sp.	*Tiliqua gigas* Schn.
P. sp.	*Varanus gouldii* Gray.
P. sp.	*Varanus varius* Shaw.

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ORDINARY MONTHLY MEETING.

30th November, 1921.

Mr. G. A. Waterhouse, B.Sc., B.E., F.E.S., President, in the Chair.

Mr. Marcus Baldwin Welch, B.Sc., A.I.C., Technological Museum, Harris Street, Ultimo, was elected an Ordinary Member of the Society.

Candidates for Linnean Macleay Fellowships, 1922-23, were reminded that to-day was the last day for lodging applications with the Secretary.

The Donations and Exchanges received since the previous Monthly Meeting (26th October, 1921), amounting to 4 Vols., 42 Parts or Nos., 9 Bulletins, 4 Reports and 4 Pamphlets, etc., received from 36 Societies and Institutions, were laid upon the table.

NOTES AND EXHIBITS.

Dr. H. G. Chapman exhibited a series of paintings by Miss Rosa Fiveash of flowers of variants of *Clianthus Dampieri* collected by Dr. O. M. Moulden in the neighbourhood of Broken Hill. Dr. Moulden had collected a number of these variants and removed them to an area within the town, and was engaged in a study of the plants.

Dr. R. J. Tillyard exhibited larvae, pupae and imagines of two new species of ***Blepharoceridae***, one taken at Mt. Kosciusko, the other at Wentworth Falls. Except for a single specimen taken at Kuranda, this family has not been recorded from Australia, and has been generally supposed to be absent from the temperate parts. The family is best represented in North and South America and in New Zealand. The whole life-history is passed on or near the face of a waterfall, even the imagines clinging close to the rushing water or flying in the spray. The species found at Kosciusko is the largest and most archaic yet discovered.

Mr. W. F. Blakely exhibited from the National Herbarium, the following unrecorded introduced weeds for this State: (1) *Chenopodium vulvaria* L., "Stinking Goosefoot," (Yass district, per Chief Inspector of Stock), a common weed in most countries, in fields and waste places; "it is widespread in Victoria," Ewart (Weeds and Poi. Pl., 75). (2) *Sisymbrium Sophio* L., "Flixweed or Fluxweed," (Ando, Bombala District, Stock Inspector Kenny), one of the Hedge Mustards, very widely distributed throughout Europe and Asia; like other allied species there is a danger of it becoming a menace to agriculture in this country as the conditions are favourable to its development. It is a new weed for the Commonwealth. (3) *Centaurea picris* Pall. (Acroptilon picris), "Hard Heads." This spineless species, a native of the Caspian Region, has recently appeared in the Henty district. Professor Ewart records it for Victoria (*vide* Vic. Nat., xxiii., 1907, 184).

Mr. E. Cheel exhibited a collection of seeds of various species of Coral Trees, *Erythrina* spp. as follows:—*Erythrina indica* Lam., collected at Lautoka, Fiji, in July, 1918. The specimens agree with those in the National Herbarium from the Philippine Is., but are quite distinct from those plants common in Public Parks and gardens in the neighbourhood of Sydney and the Illawarra District. The latter appear to be *E. corallodendron* Linn., and have hitherto been confused with *E. indica*. So far as he could ascertain no pods or seeds have been collected from trees of the latter species grown in New South Wales. In the National Herbarium there are a few seeds, received from the late F. M. Bailey from Brisbane labelled *E. indica*, which are identical with specimens of *E. corallodendron*, received from Professor C. F. Baker of Panama College, collected in Nicaragua and distributed under No. 123. The seeds of *E. corallodendron* are of a bright red colour and somewhat resemble those of *E. caffra* Thunb. which is cultivated in the Botanic Gardens, but are larger. The flowers are very different. Specimens of a white flowering form of *E. indica* from Fiji were also exhibited.

Mr. A. N. Burns exhibited larvae, pupae and perfect insects of *Paralucia aurifer* Blanch. The larvae feed at night on the leaves of the blackthorn (*Bursaria*) and hide during the day at the base of the plant; they were found at Narrabeen during September and November and as usual were attended by ants. He also exhibited larva, pupae and perfect insects of *Protialmenus lithochroa* Waterhouse, collected by Mr. J. D. O. Wilson at Reynella, S. Aust., the food plant being *Acacia pycnantha*.

Miss M. I. Collins exhibited specimens of *Clianthus Dampieri* showing colour variations from Broken Hill, and germinating seeds of *Crinum* sp.

Professor David exhibited a specimen of fossil wood, bored by Teredo, from the base of the Rolling Downs Formation of Queensland, and a specimen and microsections of limestone from the same Formation at the Maranoa River containing abundant microzoa (Radiolaria, *Tintinnus*, etc.) and Diatoms; also samples of petrol absorbed from the natural gas at the Roma Bore, Queensland, depth 3700 feet, and paraffin wax from the Ruthven Bore, 4100 feet, Central Western Queensland.

THE FOOD PLANTS OR HOSTS OF SOME FIJIAN INSECTS.*

By Robert Veitch, B.Sc. and William Greenwood, H.D.A.

The authors of this article have been investigating the sugar-cane pests of the Fiji Islands during the past few years, and in the course of their work they have obtained a considerable number of food plant records; host records have also been obtained for a number of parasitic, predaceous and blood-sucking insects. It is now thought advisable to publish these and to incorporate with them all available records made by other workers. While it is hoped that this list is complete to date it is possible that some records may occur in publications not in the possession of the authors; such records, if they do occur, must, however, be few in number. Credit for the various records is made by initials as follows:—

A.K.	Albert Koebele	D.N.	David North
F.M.	Frederick Muir	W.F.	Walter Froggatt
C.K.	Charles Knowles	T.B.	Thomas Broun
F.J.	Frank Jepson	R.V.	Robert Veitch
J.I.	James Illingworth	W.G.	William Greenwood

Most of the insects credited to the authors have been identified through the Imperial Bureau of Entomology, and the staff of the Sydney Botanic Gardens has also assisted by naming a number of the plants; the rest of the authors' insect and plant identifications have been made from their available literature.

While it is believed that the present list contains all available records to date, it is incomplete in that the feeding habits of only a very small proportion of Fijian insects are known at present; it is hoped, however, that further records will be published at a later date as information is obtained.

The food plants are recorded under their botanical names, but the following are the common names of a few of the more important plants mentioned in the list of records.

Avocado Pear	*Persea gratissima* Gaertn. (Laurineae).
Bamboo	*Schizostachyum glaucifolium* Munro (Gramineae).
Banana	*Musa sapientum* L. (Scitamineae).
Barley	*Hordeum vulgare* L. (Gramineae).
Castor Oil Plant	*Ricinus communis* L. (Euphorbiaceae).

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Cocoa	*Theobroma Cacao* L. (Sterculiaceae).
Cocoanut	*Cocos nucifera* L. (Palmae).
Coral Tree	*Erythrina indica* Lam. (Leguminosae).
Cotton (Sea Island)	*Gossypium barbadense* L. (Malvaceae).
Couch Grass	*Cynodon Dactylon* Pers. (Gramineae).
Cowpea	*Vigna Catiang* Walp. (Leguminosae).
Egg Plant	*Solanum Melongena* L. (Solanaceae).
Granadilla	*Passiflora quadrangularis* L. (Passifloreae).
Guava	*Psidium Guayava* L. (Myrtaceae).
Guinea Grass	*Panicum maximum* Jacq. (Gramineae).
Ivi Tree	*Inocarpus edulis* Forst. (Leguminosae).
Kavika	*Eugenia malaccensis* L. (Myrtaceae).
Lemon	*Citrus Medica* L. var. *limonum* (Rutaceae).
Lime	*Citrus Medica* L. var. *acida* (Rutaceae).
Maize	*Zea Mays* L. (Gramineae).
Mandarin	*Citrus Aurantium* L. var. *nobilis* (Rutaceae).
Mango	*Mangifera indica* L. (Anacardiaceae).
Mauritius Bean	*Mucuna aterrima* Holland (Leguminosae).
Oats	*Avena sativa* L. (Gramineae).
Orange (Sweet)	*Citrus Aurantium* L. (Rutaceae).
Pawpaw	*Carica Papaya* L. (Passifloreae).
Pineapple	*Ananas sativus* Schult. f. (Scitamineae).
Potato	*Solanum tuberosum* L. (Solanaceae).
Pumpkin	*Cucurbita Pepo* DC. (Cucurbitaceae).
Rain Tree	*Enterolobium Saman* Prain (Leguminosae).
Rattle Pod	*Crotalaria striata* DC. (Leguminosae).
Rice	*Oryza sativa* L. (Gramineae).
Rice Bean	*Phaseolus calcaratus* Roxb. (Leguminosae).
Royal Palm	*Oreodoxa regia* Humbt. (Palmae).
Sago Palm	*Sagus vitiensis* H. Wendl. (Palmae).
Sandalwood Tree	*Santalum yasi* Seem. (Santalaceae).
Sugar-Cane	*Saccharum officinarum* L. (Gramineae).
Sunflower	*Helianthus annuus* L. (Compositae).
Sweet Potato	*Ipomoea Batatas* Lam. (Convolvulaceae).
Thurston Grass	*Panicum distachyum* L. (Gramineae).
Tobacco	*Nicotiana Tabacum* L. (Solanaceae).
Tomato	*Lycopersicum esculentum* Mill. (Solanaceae).
Water Melon	*Citrullus vulgaris* Schrad. (Cucurbitaceae).
Yaqona	*Piper methysticum* Forst. (Piperaceae).

It is hoped that this list will be of assistance to any readers who may be unacquainted with botanical nomenclature.

A single asterisk (*) opposite an insect record indicates that that insect is of great economic importance, two asterisks (**) similarly placed classify the insect as being of some considerable importance, while three asterisks (***) indicate that, although the insect attacks economic plants, insects or animals, yet its presence in Fiji is of very little consequence; where no asterisk occurs it is understood that the insect in question has either not yet been recorded as attacking anything of importance in the economic life of the community or, if it has done so, the object of attack has been in a rotting or decayed condition. The economic status of each insect has been determined from Fijian records only and, if the insect in question happens to be widely distributed or cosmopolitan, has no reference to its status in other parts of the world.

LEPIDOPTERA.

Except where otherwise stated, the records for Lepidoptera refer to the feeding habits of the larvae.

Nymphalidae.

Danaida archippus F. Feeds on the leaves and stalks of *Asclepias curassavica* L. (Asclepiadeae). R.V.

* * * *Melanitis leda* F. Eats the leaves of *Saccharum officinarum* L. (Gramineae). R.V.

Lycaenidae.

* * * *Zizera labradus* Godt. Feeds on the flowers of *Vigna Catiang* Walp. (Leguminosae). W.G.

Sphingidae.

Chromis erotus Cram. Feeds on the leaves of *Morinda citrifolia* L. (Rubiaceae). W.G.

Macroglossum hirundo Boisd. Also feeds on the leaves of *Morinda citrifolia* L. (Rubiaceae). W.G.

Zygaenidae.

* *Levuana iridescens* B-B. Destroys the leaves of the following:—*Areca catechu* L. (Palmae) F.J.; *Cocos nucifera* L. (Palmae) C.K.; *Oreodoxa regia* Humbt. (Palmae) F.J.; *Sagus vitiensis* H. Wendl. (Palmae) F.J.

Hypsidae.

Argyna astrea Drury. Eats the flowers and young pods of *Crotalaria striata* DC. (Leguminosae). R.V.

Deilemera fasciata Wlk. Feeds on the leaves and shoots of *Emilia sonchifolia* DC. (Compositae). W.G.

Arctiidae.

Utetheisa pulchella L. Eats the green pods of *Crotalaria striata* DC. (Leguminosae). R.V.

Geometridae.

* * * *Thalassodes pilaria* Gn. Feeds on the leaves of *Rosa* sp. Garden variety (Rosaceae). R.V.; also eats the leaves of *Ricinus communis* L. (Euphorbiaceae). R.V.

Noctuidae.

* * * *Achaea janata* L. Destroys the leaves of *Rosa* sp. Garden variety (Rosaceae). R.V.

Amyna natalis Wlk. Feeds on the leaves of *Sida retusa* L. (Malvaceae). W.G.

* * * *Anticarsia irrorata* F. Feeds on the leaves of *Phaseolus calcaratus* Roxb. (Leguminosae). W.G.; also destroys the leaves of *Saccharum officinarum* L. (Gramineae). R.V.

* * * *Cirphis loreyi* Dup. Eats the leaves of *Saccharum officinarum* L. (Gramineae). R.V.; also feeds on the leaves of many other Gramineae. R.V. and W.G.

* * *C. unipuncta* Haw. Destroys the leaves of *Saccharum officinarum* L. (Gramineae). R.V.; also feeds on the leaves of other Gramineae. R.V. and W.G.

* * *Earias fabia* Stoll. Feeds on the flower buds of *Hibiscus rosa-sinensis* L. (Malvaceae). C.K.; also attacks the buds of *Gossypium barbadense* L. (Malvaceae). C.K.

* * * *Othreis fullonica* L. The larva feeds on the leaves of ***Erythrina indica*** Lam. (Leguminosae). R.V. and the imago on the ripe fruit of ***Musa sapientum*** L. (Scitamineae). R.V. and also on the fruit of ***Citrus Aurantium*** L. (Rutaceae). F.J.

* * * ***Phytometra chalcites*** Esp. Feeds on the leaves of ***Phaseolus calcaratus*** Roxb. (Leguminosae). R.V.

* * ***Prodenia litura*** F. Destroys the leaves of the following plants:—***Dahlia*** sp. Garden variety (Compositae) R.V.; ***Helianthus annuus*** L. (Compositae) R.V.; ***Mucuna aterrima*** Holland (Leguminosae) R.V.; ***Nicotiana Tabacum*** L. (Solanaceae) R.V.; ***Passiflora quadrangularis*** L. (Passifloreae) R.V.; also eats the flowers of ***Begonia*** sp. Garden variety. (Begoniaceae). F.J.

* * * ***Spodoptera mauritia*** Boisd. Feeds on the leaves of ***Panicum maximum*** Jacq. (Gramineae). R.V.

Pyralidae.

* * ***Harpagoneura complexa*** Boisd. Eats the fruit stalk of ***Cocos nucifera*** L. (Palmae). C.K.

Hyphantidium albicostale Wlk. Feeds in the ripe fruits of ***Barringtonia speciosa*** Forst. (Lecythidaceae). R.V.

* * * ***Maruca testulalis*** Hb. Feeds on the green pods of ***Vigna Catiang*** Walp. (Leguminosae). R.V.; also destroys the flowers of ***Pueraria Thunbergiana*** Benth. (Leguminosae). W.G. and the flowers and pods of ***Sophora tomentosa*** L. (Leguminosae). W.G.

* * * ***Nacoleia diemenalis*** Gn. Feeds on the leaves of the following plants:—***Phaseolus calcaratus*** Roxb. (Leguminosae) W.G.; ***Pueraria Thunbergiana*** Benth. (Leguminosae). W.G.

* * * ***N. octosema*** Meyr. Feeds on the fruits of ***Musa sapientum*** L. (Scitamineae). F.J.

Terastia meticulosalis Gn. Feeds in the ripe pods of ***Erythrina indica*** Lam. (Leguminosae). R.V.

Tortricidae.

* * * ***Argyroploce illepida*** Butl. Feeds in the fruits of ***Inocarpus edulis*** Forst. (Leguminosae). R.V.

Lyonetiidae.

* * * ***Decadarchis flavistriata*** Wals. Feeds on the leaf sheaths, eyes and rind of ***Saccharum officinarum*** L. (Gramineae). R.V.

* * * ***D. heterogramma*** Meyr. Feeds on the floral bracts of ***Passiflora quadrangularis*** L. (Passifloreae). R.V.

* * * ***Opogona regressa*** Meyr. Also feeds on the floral bracts of ***Passiflora quadrangularis*** L. (Passifloreae). R.V.

Tineidae.

* * * ***Setomorpha rutella*** Zell. Feeds on the seeds of ***Phaseolus semierectus*** L. (Leguminosae). R.V.

* * * ***Trachycentra calamias*** Meyr. Feeds in the "cabbage" and in the base of the leaf stalk of ***Cocos nucifera*** L. (Palmae) F.J.; also bores in the stalk of ***Saccharum officinarum*** L. (Gramineae) F.J. and in the stem of ***Musa sapientum*** L. (Scitamineae). F.J.

* * ***T. chlorogramma*** Meyr. Tunnels in the stalk of ***Saccharum officinarum*** L. (Gramineae). R.V.

Gelechiidae.

* * * ***Brachyacma epiochra*** Meyr. Feeds in the ripe pods of the following:—***Crotalaria striata*** DC. (Leguminosae) W.G.; ***Vigna Catiang*** Walp. (Leguminosae). W.G.

* * *Phthorimaea operculella* Zell. Feeds on the leaves of *Nicotiana Tabacum* L. (Solanaceae). F.J.

Phyllorycteridae.

* * * *Cyphosticha caerulea* Meyr. Feeds just under the epidermis of the leaves of the following plants:—*Phaseolus calcaratus* Roxb. (Leguminosae) W.G.; *P. semierectus* L. (Leguminosae) W.G.; *Vigna Catiang* Walp. (Leguminosae). R.V.

Lithocolletis aglaozona Meyr. Feeds just under the epidermis of the leaves of *Pueraria Thunbergiana* Benth. (Leguminosae). W.G.

Cosmopterygidae.

* * * *Cosmopteryx dulcivora* Meyr. Tunnels in the midribs of the leaves of *Saccharum officinarum* L. (Gramineae). R.V.

Lavernidae.

* * * *Pyroderces terminella* Wlk. Feeds in the ripe pods of *Vigna Catiang* Walp. (Leguminosae). R.V.

* * * *Stagmatophora erebinthia* Meyr. Feeds in the ripe pods of *Vigna Catiang* Walp. (Leguminosae). W.G.

Heliodinidae.

Stathmopoda trichrysa Meyr. Feeds in the flower buds of *Barringtonia speciosa* Forst. (Lecythidaceae) W.G.; also feeds on the flowers of *Desmodium umbellatum* D.C. (Leguminosae). W.G.

COLEOPTERA.

The stage in which the insect does the damage is indicated in all the records for Coleoptera; this has been rendered necessary by the fact that in many cases the damage has been caused by both the imago and the larva, while in a few cases the imago alone has been responsible for the injury. The remaining records refer to larval attack only, and they constitute the majority of the records for Coleoptera; the list contains a number of instances of predaceous and parasitic habits.

Lucanidae.

Figulus foveicollis Boisd. The larvae feed in the dead timber of *Inocarpus edulis* Forst. (Leguminosae). R.V.

Aphodiidae.

Aphodius lividus Oliv. The larvae live in mule excrement. D.N.; also in human excrement. W.G.

Melolonthidae.

* * *Rhopaea subnitida* Arrow. The larvae eat the roots and the bases of the shoots of *Saccharum officinarum* L. (Gramineae) R.V.; the imago feeds on the leaves of the following plants:—*Cocos nucifera* L. (Palmae) R.V.; *Psidium Guayava* L. (Myrtaceae). R.V.

* *R. vestita* Arrow. The larvae eat the roots and the bases of the shoots of *Saccharum officinarum* L. (Gramineae) R.V. and the imago feeds on the leaves of the following plants:—*Cocos nucifera* L. (Palmae) R.V.; *Enterolobium Saman* Prain (Leguminosae) R.V.; *Psidium Guayava* L. (Myrtaceae) R.V.; *Saccharum officinarum* L. (Gramineae). R.V.

Rutelidae.

* * *Adoretus versutus* Har. The larva eats the roots of *Saccharum officinarum* L. (Gramineae) R.V.; the imago eats the leaves of the following plants:—*Rosa* sp. Garden variety (Rosaceae) F.J.; *Saccharum officinarum* L. (Gramineae) R.V.; *Theobroma Cacao* L. (Sterculiaceae). C.K.

Cetoniidae.

* * * *Protaetia fusca* Herbst. The imago eats the fruit of *Passiflora quadrangularis* L. (Passifloreae). R.V.

Hydrophilidae.

Cyclonotum subquadratum Fairm. The imago feeds on the rotten stalks of *Saccharum officinarum* L. (Gramineae). R.V.

Histeridae.

* * * *Plaesius javanus* Er. The larva and imago feed on the larva of *Cosmopolites sordidus* Germ. (Curculionidae). F.J.

Nitidulidae.

Carpophilus dimidiatus F. The larva and imago feed on the rotten stalks of *Saccharum officinarum* L. (Gramineae). R.V.

C. mutabilis Fairm. The larva and imago feed on the rotten stalks of *Saccharum officinarum* L. (Gramineae). R.V.

Trogositidae.

* * * *Lophocateres pusillus* Klug. The larvae feed in bran. R.V.

* * * *Tenebroides mauritanicus* L. The imago feeds on *Calandra oryzae* L. (Curculionidae) R.V. and the larva attacks the seeds of *Oryza sativa* L. (Gramineae). R.V.

Colydiidae.

Neotrichus latiusculus Fairm. The imago feeds on the rotten stalks of *Saccharum officinarum* L. (Gramineae). R.V.

Cucujidae.

Cryptamorpha desjardinsi Guér. The imago feeds on the rotten stalks of *Saccharum officinarum* L. (Gramineae). R.V.

* * * *Laemoploeus pusillus* Schonh. The larva feeds in bran. R.V.

* * * *Silvanus surinamensis* L. The larvae feed in dates. R.V.

Coccinellidae.

* * *Anisorcus affinis* Crotch. The larva and imago feed on *Coccidae* generally. F.M. R.V. and W.G.

* * *Coccinella 8-maculata* F. The larva and imago feed on *Aphiidae* generally. R.V. and W.G.

* * *C. transversalis* F. The larva and imago also attack *Aphiidae* generally. R.V. and W.G.

* * *Epilachna 28-punctata* F. The larva and imago eat the leaves of the following plants:—*Lycopersicum esculentum* Mill. (Solanaceae) C.K.; *Nicotiana Tabacum* L. (Solanaceae) F.J.; *Physalis minima* L. (Solanaceae) R.V.; *Solanum Melongena* L. (Solanaceae) C.K.; *S. nigrum* L. (Solanaceae) W.G.; *S. tuberosum* L. (Solanaceae). C.K.

* * *Neda tricolor* F. var. *vitiensis* Crotch. The larva and imago eat *Coccidae* and *Aphiidae* generally. F.M. and R.V.

* * * *Novius cardinalis* Muls. The larva and imago feed on *Icerya purchasi* Mask. (Coccidae). R.V.

* * * *Verania strigula* Boisd. The larva and imago eat the nymphs of *Perkinsiella vitiensis* Kirk. (Asiracidae) in captivity. F.M.

Bostrychidae.

* * * *Rhizopertha dominica* F. The larvae feed in bran. R.V.

* * * *Xylopsocus castanoptera* Fairm. The larvae tunnel in the trunk and branches of *Theobroma Cacao* L. (Sterculiaceae). C.K.

* * * *Xylothrips religiosus* Boisd. The larvae tunnel in the trunk and branches of the following plants:—*Cassia nodosa* Buch.-Ham. (Leguminosae) C.K.; *Theobroma Cacao* L. (Sterculiaceae). C.K.

Ptinidae.

* * * *Anobium paniceum* L. The larva and imago injure books. F.J.; the larva also feeds in nutmegs. R.V.

* * *Lasioderma serricorne* F. The larva and imago destroy cigarettes. F.J.

Cleridae.

* * *Necrobia rufipes* de G. The larvae feed in copra. F.J.

Elateridae.

* * *Lacon stricticollis* Fairm. The larvae attack the roots and young shoots of *Saccharum officinarum* L. (Gramineae) R.V.; they also feed on the white grubs of *Rhopaea vestita* Arrow. (Melolonthidae). R.V.

* * *Monocrepidius pallipes* Esch. The larvae feed on the white grubs of *Rhopaea vestita* Arrow. (Melolonthidae). R.V.

* *Simodactylus cinnamomeus* Boisd. The larvae attack the roots and young shoots of *Saccharum officinarum* L. (Gramineae) R.V.; they also feed on the white grubs of *Rhopaea vestita* Arrow. (Melolonthidae). R.V.

Tenebrionidae.

Alphitobius diaperinus Panz. The larvae feed on the rotten seeds of *Vigna Catiang* Walp. (Leguminosae). R.V.

A. piceus Ol. The larvae live in the rotten seeds of *Zea Mays* (Gramineae). R.V.

Amarygmus hydrophiloides Fairm. The larvae live in rotten timber. R.V.

A. tuberculiger Fairm. The larvae also live in rotten timber. R.V.

Bradymerus amicorum Blanch. The larvae feed in rotten timber. R.V.

* * * *Gnathocerus cornutus* F. The larvae feed in the meal of *Avena sativa* L. (Gramineae). R.V.

* * *Tribolium confusum* Jacq-Duv. The larvae live in the seeds of *Zea Mays* L. (Gramineae). R.V.

Bruchidae.

* *Bruchus chinensis* L. The larvae have been found feeding in the seeds of the following plants:—*Phaseolus adenanthus* G. Meyer (Leguminosae) R.V.; *P. calcaratus* Roxb. (Leguminosae) R.V.; *P. semierectus* L. (Leguminosae) R. V.; *Vigna Catiang* Walp. (Leguminosae). R.V.

Pachymerus gonager F. The larvae feed in the pods of *Acacia farnesiana* L. (Leguminosae). R.V.

Galerucidae.

* * *Aulacophora argyrogaster* Mont. The imago eats the leaves and flowers of the following plants:—*Citrullus vulgaris* Schrad. (Cucurbitaceae) C.K.; *Cucurbita Pepo* DC. (Cucurbitaceae). C.K.

* * *A. quadrimaculata* F. The imago eats the leaves of the following plants:—*Citrullus vulgaris* Schrad. (Cucurbitaceae) R.V.; *Cucurbita Pepo* DC. (Cucurbitaceae). R.V.

Halticidae.

Haltica gravida Blckb. The larva and imago eat the leaves of *Jussiaea suffruticosa* L. (Onagraceae). R.V.

Hispidae.

* * *Promecotheca reichei* Baly. The larva injures the leaves of *Cocos nucifera* L. (Palmae). C.K.

Anthribidae.

* * *Araecerus fasciculatus* de G. The larvae have been found feeding in the following:—*Citrus Aurantium* L. (Rutaceae) F.J.; Dates R.V.; Dried Ginger F.J.; Nutmegs R.V.

Curculionidae.

Acicnemis biconifer Fairm. The larvae feed in the decaying wood of *Jatropha Curcas* L. (Euphorbiaceae). R.V.

* * *Calandra granaria* L. The larvae feed in the seeds of *Zea Mays* L. (Gramineae). C.K.

* *C. oryzae* L. The larvae feed in the seeds of the following plants:—*Avena sativa* L. (Gramineae) R.V.; *Hordeum vulgare* L. (Gramineae) R.V.; *Oryza sativa* L. (Gramineae) F.J.; *Zea Mays* L. (Gramineae). F.J.

* * * *C. taitensis* Guér. The larvae feed in the leaf stalk of *Cocos nucifera* L. (Palmae). F.J.

* *Cosmopolites sordidus* Germ. The larvae tunnel in the roots of *Musa sapientum* L. (Scitamineae). C.K.

* * *Cylas formicarius* F. The larvae tunnel in the tuberous roots of *Ipomoea Batatas* Lam. (Convolvulaceae). R.V.

* * * *Euscepes batatae* Waterh. The larvae also attack the roots of *Ipomoea Batatas* Lam. (Convolvulaceae). R.V.

* *Rhabdocnemis obscura* Boisd. The larvae tunnel in the stalks of *Saccharum officinarum* L. (Gramineae). A.K.; the larvae also attack *Musa sapientum* L. (Scitamineae). A.K.

* * * *Trochorrhopalus strangulatus* Gyl. The larvae tunnel in sickly and rotten stalks of *Saccharum officinarum* L. (Gramineae). J.I.

Scolytidae.

* * * *Coccotrypes dactyliperda* F. The larvae feed in dates. R.V.

Stylopidae.

* * *Elenchoides perkinsi* Pierce. All stages of the female of this insect are parasitic on the nymph and imago of *Perkinsiella vitiensis* Kirk. (Asiracidae); all stages of the male except the imaginal are also parasitic upon *P. vitiensis* Kirk. A.K. It also similarly attacks the nymph and imago of *Nephotettix plebeius* Kirk. (Tetigoniidae). W.G.

HYMENOPTERA.

Except where otherwise stated, the records for Hymenoptera refer to the feeding habits of the larvae.

Eulophidae.

* *Ootetrastichus beatus* Perk. Parasitic on the eggs of *Perkinsiella vitiensis* Kirk. (Asiracidae). A.K.

Encyrtidae.

* * *Ooencyrtus pacificus* Waterst. Parasitises the eggs of *Brachyplatys pacificus* Dal. (Pentatomidae). R.V.

Braconidae.

* * * *Apanteles expulsus* Turn. Parasitic on the larvae of *Anticarsia irrorata* F. (Noctuidae). R.V.

Eumenidae.

* * * *Rhynchium rufipes* F. The imago stores the larvae of *Maruca testulalis* Hb. (Pyralidae) in its larval mud cells. W.G.

Vespidae.

* *Polistes hebraeus* F. The larva and imago feed on insects generally. J.I. and R.V.

Scoliidae.

* * *Discolia ovalauensis* Sauss. The larvae are parasitic on the white grubs of *Rhopaea vestita* Arrow. (Melolonthidae). R.V.

Formicidae.

* *Pheidole megacephala* F. This is a general predator on all stages of other insects. Various observers.

HEMIPTERA.

In practically all the Hemiptera the records refer to the feeding habits of nymph and imago; the *Coccidae* are an exception because of the fact that the mouth-parts of the male imago are aborted and incapable of absorbing plant juices.

Pentatomidae.

* * *Brachyplatys pacificus* Dall. Feeds on the leaves, stalks and pods of *Mucuna aterrima* Holland. (Leguminosae). R.V.

* * * *Canthecona cyanocantha* Stal. Attacks the larvae of *Levuana iridescens* B-B. (Zygaenidae). F.J.

Coleotichus sordidus Wlk. Feeds on the leaves and flower buds of *Hibiscus tiliaceus* L. (Malvaceae). R.V.

* * * *Lamprophara bifasciata* White. Attacks the larvae of *Levuana iridescens* B-B. (Zygaenidae). R.V.

* * * *Piezodorus rubrofasciatus* F. Feeds on the leaves and fruits of *Passiflora quadrangularis* L. (Passifloreae). W.G.

* * * *Tectocoris lineola* F. Attacks the larvae of *Levuana iridescens* B-B. (Zygaenidae). R.V.

Coreidae.

* * * *Brachylybas variegatus* Le Guill. Feeds on the leaves of *Carica Papaya* L. (Passifloreae). R.V.

* * * *Leptocorisa acuta* Stal. Feeds on the leaves and inflorescences of *Gramineae* generally. R.V. and W.G.

* * * *Leptoglossus australis* F. Attacks the leaves, stalks and pods of the following plants:—*Cassia occidentalis* L. (Leguminosae) R.V.; *Vigna Catiang* Walp. (Leguminosae). W.G.

Melanacanthus margineguttatus Dist. Feeds on the leaves, stalks and pods of *Cassia occidentalis* L. (Leguminosae). R.V.

Mictis profana F. Attacks the leaves, stalks and pods of the following plants:—*Cassia occidentalis* L. (Leguminosae) R.V.; *Desmodium umbellatum* DC. (Leguminosae). W.G.

Riptortus abdominalis Westw. Feeds on the leaves, stalks and pods of *Cassia occidentalis* L. (Leguminosae). R.V.

Lygaeidae.

* * * *Graptostethus servus* F. var. Attacks the leaves of *Zea Mays* L. (Gramineae). R.V.

Paromius pallidus Montr. Feeds on the inflorescence of *Amphilophis glabra* Stapf. (Gramineae). W.G.

Pyrrhocoridae.

* * * *Dysdercus impictiventris* Stal. Attacks the bolls, leaves and young shoots of *Gossypium barbadense* L. (Malvaceae). R.V.

* * * *D. insularis* Stal. Attacks *Gossypium barbadense* L. (Malvaceae) in a similar manner. F.J.

Cimicidae.

* * *Clinocoris hemiptera* F. Attacks human beings. F.J.

Capsidae.

Gallobelicus crassicornis Dist. Feeds on the leaves of *Polanisia viscosa* DC. (Capparideae). W.G.

Tetigoniidae.

* * * *Nephotettix plebeius* Kirk. Feeds on the leaves of *Panicum distachyum* L. (Gramineae). W.G.

Nesosteles sanguinescens Kirk. Feeds on the inflorescence of *Amphilophis glabra* Stapf. (Gramineae). W.G.

Asiracidae.

* * *Peregrinus maidis* Ashm. Attacks the leaves and stalks of *Zea Mays* L. (Gramineae). R.V.

* * *Perkinsiella vitiensis* Kirk. Feeds on the leaves and stalks of *Saccharum officinarum* L. (Gramineae). A.K.

Derbidae.

* * * *Pyrrhoneura sacchariclda* Kirk. Attacks the leaves and stalks of *Saccharum officinarum* L. (Gramineae). F.M.

Aleurodidae.

* * * *Aleurodes bergii* Sign. Feeds on the leaves of *Saccharum officinarum* L. (Gramineae). A.K.

* * * *A. comata* Mask. Attacks the leaves of the following plants:—*Cynodon dactylon* Pers. (Gramineae) W.G.; *Panicum distachyum* L. (Gramineae) R.V.; *Saccharum officinarum* L. (Gramineae). F.M.

A. calophylli Kot. Attacks *Calophyllum Inophyllum* L. (Guttiferae) †

* * * *A. sacchari* Mask. Feeds on the leaves of *Saccharum officinarum* L. (Gramineae) †

* * * *Aleurodicus holmesii* Mask. Attacks *Psidium Guayava* L. (Myrtaceae) †

Coccidae.

* * * *Aspidiotus cyanophylli* Sign. Attacks the following plants:—*Musa sapientum* L. (Scitamineae) F.J.; *Psidium Guayava* L. (Myrtaceae). F.J.

* *A. destructor* Sign. var. *transparens* Green. Attacks the following plants: *Carica Papaya* L. (Passifloreae) F.J.; *Cocos nucifera* L. (Palmae) F.J.; *Musa sapientum* L. (Scitamineae) F.J.; *Passiflora quadrangularis* L. (Passifloreae) F.J.; *Persea gratissima* Gaertn. (Laurineae) F.J.; *Piper methysticum* Forst. (Piperaceae). F.J.

* * * *A. excisus* Green. Feeds on *Musa sapientum* L. (Scitamineae). F.J.

* * * *A. lataniae* Sign. Attacks *Musa sapientum* L. (Scitamineae). F.J.

* * * *A. palmae* Ckll. Also attacks *Musa sapientum* L. (Scitamineae). F.J.

Asterolecanium miliaris-longum Green. Feeds on *Schizostachyum glaucifolium* Munro (Gramineae). F.J.

* * *Chionaspis citri* Comst. Attacks the following:—*Citrus Aurantium* L. (Rutaceae) F.J.; *C. Aurantium* L. var. *nobilis* (Rutaceae) F.J.; *C. Medica* L. var. *acida* (Rutaceae) F.J.; *C. Medica* L. var. *limonum* (Rutaceae). F.J.

* * *Chrysomphalus (Aspidiotus) aurantii* Mask. Attacks the following plants:—*Citrus Aurantium* L. (Rutaceae) F.J.; *C. Medica* L. var. *limonum* (Rutaceae) F.J.; *Musa sapientum* L. (Scitamineae). F.J.

* * * *C. dictyospermi* Morgan. Feeds on *Musa sapientum* L. (Scitamineae). F.J.

Diaspis (Aulacaspis) pentagona Targ. Attacks *Hibiscus esculentus* L. (Malvaceae). F.J.

* * *Diaspis bromeliae* Kerner. Feeds on *Ananas sativus* Schult. f. (Scitamineae). F.J.

* * * *D. rosae* Sandberg. Attacks *Rosa* sp. Garden variety. (Rosaceae). F.J.

* * * *Hemichionaspis aspidistrae* Sign. Feeds on *Musa sapientum* L. (Scitamineae). F.J.

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†These records have been obtained from Bulletin No. 2 issued by the Board of Commissioners of Agriculture and Forestry of the Territory of Hawaii; that bulletin does not indicate to whom credit should be given for these food plant records. It has, however, been thought desirable to include them in the present list, even although the recorders names cannot be given.

* * * *H. minor* Mask. Attacks *Musa sapientum* L. (Scitamineae). F.J.

* * * *Icerya purchasi* Mask. Feeds on the following plants:—*Citrus Aurantium* L. (Rutaceae) R.V.; *C. Medica* L. var. *limonum* (Rutaceae) R.V.; *Psidium Guayava* L. (Myrtaceae). R.V.

* * * *Pseudococcus bromeliae* Bouché. Attacks *Saccharum officinarum* L. (Gramineae). R.V.

* * * *P. pandani* Ckll. Feeds on *Cocos nucifera* L. (Palmae). F.J.

ANOPLURA.

The Anoplura feed on the blood of mammals.

Pediculidae.

* * *Pediculus capitis* De Geer. On human beings. F.J.

* * *P. humanus* L. On human beings. F.J.

* * *Phthirus inguinalis* Leach. On human beings. F.J.

Haematopinidae.

* * * *Haematopinus eurysternus* Nitzsch. On cattle. F.J.

* * * *H. suis* L. var. *adventitius* Neumann. On pigs. F.J.

* * * *H. urius* Nitzsch. On pigs. F.J.

ORTHOPTERA.

All the records for Orthoptera refer to the feeding habits of both nymph and imago.

Gryllidae.

* * *Gryllus oceanicus* Le Guill. Feeds on the young shoots and eyes of *Saccharum officinarum* L. (Gramineae). R.V.

Acridiidae.

* * * *Cyrtacanthacris guttulosa* Wlk. Eats the leaves of *Saccharum officinarum* L. (Gramineae). R.V.

* * * *Locusta danica* L. Attacks the leaves of *Saccharum officinarum* L. (Gramineae). R.V.

Phasmidae.

* * *Graeffea cocophaga* Newp. Attacks the leaves of *Cocos nucifera* L. (Palmae) †

* * *Hermarchus pythonius* Westw. Feeds on the leaves of *Cocos nucifera* L. (Palmae) †

THYSANURA.

Lepismidae.

* * *Lepisma saccharina* L. Both the nymph and imago infest books, photographs, cardboard boxes and other articles containing the starchy matter on which they feed. F.J.

NEUROPTERA.

Chrysopidae.

* * *Chrysopa sanvitoresi* Nav. The larvae feed very voraciously on *Coccidae* generally. R.V.

MALLOPHAGA.

The Mallophaga feed on the more delicate portions of the hairs and feathers of their hosts and also upon epidermal cells.

Goniodidae.

* * * *Goniodes dissimilis* Nitzsch. On fowls. F.J.

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† Original observer's name is unknown to the authors.

Menoponidae.

* * * *Menopon trigonocephalum* Olfers. On fowls. F.J.

Trichodectidae.

* * * *Trichodectes climax* Nitzsch. On goats. F.J.

Lipeuridae.

* * * *Lipeurus heterographus* Nitzsch. On fowls. F.J.

DIPTERA.

The records for *Culicidae* and *Tabanidae* refer to the blood sucking habits of the female imago only; the records for *Trypetidae, Drosophilidae* and *Tachinidae* indicate the feeding habits of the larva.

Culicidae.

* *Culex fatigans* Wied.	Attacks human beings.	F.J.
* * *C. jepsoni* Theo.	" " "	F.J.
* * *C. nocturnus* Theo.	" " "	F.J.
* * *Finlaya poicilia* Theo.	" " "	F.J.
* *Stegomyia fasciata* F.	" " "	F.J.
* *S. pseudoscutellaris* Theo.	" " "	F.J.
* * *Taeniorhynchus brevicellulus* Theo.	" " "	F.J.

Tabanidae.

* * * *Tabanus fijianus* Ric. Attacks human beings. W.G.

Trypetidae.

Dacus curvipennis Frogg.† Attacks the fruit of *Musa sapientum* L. (Scitamineae). W.F.

* * *D. passiflorae* Frogg. Lives in the fruits of the following plants:— *Citrus Aurantium* L. (Rutaceae) F.J.; *C. Aurantium* L. var. *nobilis* (Rutaceae) F.J.; *Eugenia malaccensis* L. (Myrtaceae) W.G.; *Mangifera indica* L. (Anacardiaceae) F.J.; *Passiflora quadrangularis* L. (Passifloreae) F.J.; *Pometia pinnata* Forst. (Sapindaceae) F.J.; *Psidium Guayava* L. (Myrtaceae). F.J.

This species has also been bred from the seeds of *Santalum yasi* Seem. (Santalaceae). F.J.

D. psidii Frogg.† Attacks the fruits of *Passiflora quadrangularis* L. (Passifloreae). W.F.

D. xanthodes Broun.† Attacks the fruits of the following plants:— *Ananas sativus* Schult. f. (Scitamineae) T.B.; *Carica Papaya* L. (Passifloreae) T.B.; *Passiflora quadrangularis* L. (Passifloreae) T.B.; *Psidium Guayava* L. (Myrtaceae). T.B.

Drosophilidae.

* * * *Drosophila ampelophila* Lw. Feeds on the skin of the fruit of *Musa sapientum* L. (Scitamineae). F.J.

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†None of these species have been bred in Fiji, and the records have all been obtained from fruit landed in Australia and New Zealand; the records for D. xanthodes Broun have been taken from Froggatt's "Report on Parasitic and Injurious Insects" on p. 91 of which he states "This name was given to a species, bred by Captain Broun in New Zealand, from larvae obtained infesting pineapples, granadillas, guavas, and mammee apples brought from Suva and Raratonga, Fiji." It is not clear from this note whether all four food plant records were obtained from Fijian fruit or whether some were obtained from Raratongan fruit and some from Fijian fruit.

Tachinidae.

* *Ceromasia sphenophori* Vill. Parasitic on the larvae of *Rhabdocnemis obscura* Boisd. (Curculionidae). F.M.

* * *Sturmia bimaculata* Htg. Parasitic on the larvae of the following:—*Chromis erotus* Cram. (Sphingidae) W.G.; *Cirphis loreyi* Dup. (Noctuidae) R.V.; *C. unipuncta* Haw. (Noctuidae) R.V.; *Prodenia litura* F. (Noctuidae). R.V.

Muscidae.

* *Musca domestica* L. The larvae feed in excrement. F.J.

* * * *Stomoxys calcitrans* L. The imago sucks the blood of horses. F.J.; it also attacks human beings. R.V.

SIPHONAPTERA.

The Siphonaptera are blood sucking.

Pulicidae.

* * *Ctenocephalus felis* Bouché. On dogs, cats and mongoose. F.J.

* * *Echidnophaga gallinacea* Westw. Attacks domestic fowl. †

* * *Xenopsylla cheopis* Roths. Attacks rats. F.J.

† Observer's name unknown to the authors.

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Received during the period 24th November, 1920, to 30th November, 1921.

(*From the respective Societies, etc., unless otherwise mentioned.*)

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PLAYFAIR, G. I., (donor).—19 Vols. on "Algae;" 1 Vol. on "British Antarctic Expedition, 1907-1909," etc.; 1 Vol. on "Chytridiaceae" (1); 1 Vol. on "Desmidieer" (iv.); 1 Vol. on "Desmids" (1); 5 Vols. on "Diatoms"; 1 Vol. on "Diatoms and Plankton"; 1 Vol. on "Norse Plankton"; 1 Vol. on "Plankton"; 1 Vol. on "Plankton, Atlantic and Indian"; 4 Vols. on "Protozoa"; 1 Vol. on "Schwedischen Südpolar-Expedition, 1901-1903 and Pithophoraceae"; 1 Vol. on "Turbellaria" (1); "A Manual of the Infusoria" by W. S. Kent, in 2 vols. (1880/81-1881/82); "A Monograph of the British Desmidiaceae" by W. and G. S. West in 4 vols. (1904-1912); "Arctische Diatomeen" by P. T. Cleve and A. Grunos (1880); "A Synopsis of the British Diatomaceae" by Rev. William Smith in 2 Vols. (1853-1856); "British Diatomaceae" by A. S. Donkin (1871); "Das Leben der Binnengewässer" by Dr. Kurt Lampert (1899); "Das Leben des Süsswassers" by Dr. Ernst Hentschel (1909); "Der Organismus der Infusionsthiere" iii., Hälfte 1 and 2 by Dr. F. R. v. Stein (1878-1883); "Desmids of the United States, etc.," by Rev. F. Wolle (1884); "Diatomées de la Malaisie" by G. Leuduger-Fortmorel (1891); "Die Diatomeen der Hohen Tatra" by J. Schumann (1867); "Elementi per lo Studio delle Desmidiacee Italiche" by Giuseppe de-Notaris (1867); "Histoire Naturelle des Zoophytes. Infusoires" by M. Felix Dujardin (1841); "Les Diatomées d'Auvergne" by Hériband Joseph (1893); "Les Diatomées de Luchon et des Pyrénées Centrales" by Emile Belloc (1887); "Liste des Desmidiées observées en Basse-Normandie" by Alphonse de Brébisson (1856); "Monographie du Genre Rhizosolenia" by H. Peragallo (1892); "Monographie und Iconographie der Oedogoniaceen" by Karl E. Hirn (1900); "Planktonkunde" by Dr. Adolf Steuer (1910); "Plankton of the Illinois River" (1 Vol.); "Report on the Irish Diatomaceae, Part i." by Rev. E. O'Meara; "Specimen Desmidiacearum Subalpinarum" by J. B. Delponte in 2 Vols. (1873); "Spirogyra des Environs de Paris" by Paul Petit (1880); "The British Desmidieae" by John Ralfs (1848); "The Micrographic Dictionary" by J. W. Griffith and A. Henfrey. (2 Vols. in 1 Vol.) (1883); "The Rotifera; or Wheel-Animalcules" by C. T. Hudson and P. H. Gosse in 2 Vols, with Supplement (1889); and 39 Separates. (Total number of books and separates, 111).

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(except 3, 6, 20, 21), List of Members, (T. p. & c.) (1913); **xxxiii.**, 1-24 (except 3), List of Members, (T. p. & c.) (1914); **xxxiv.**, 1-24, List of Members, (T. p. & c.) (1915); xxxv., 1-24, List of Members, (1916); xxxvi., 1-20 (except 10, 13-17, 19), (1917).

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TILLYARD, Dr. R. J., M.A., F.L.S., F.E.S., New Zealand.—Three Reprints: (1) "A New Classification of the Order Perlaria" (Canadian Entomologist, Feb., 1921); (2) "The Hawthorn Hedge Menace (Nelson Evening Mail 31/12/20 and 4th & 5th Jan., 1921); (3) "Neuropteroid Insects, etc., (N.Z. Journ. Sci. & Tech. iii., 5/6, pp. 271-79, 1921).

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WALKOM, Dr. A. B., Sydney (donor).—Commonwealth Institute of Science and Industry, Bulletin, Nos. 1, 3, 4, 7 (1917-1918); Pamphlet No. 1 (1918); "The Scientific Australian," xx., 3 (1915).

WATERHOUSE, G. A., B.Sc., B.E., F.E.S., Sydney (donor).—"The Entomologist's Monthly Magazine," 2nd Ser., l. (1914); 3rd Ser., li.-lvi. (1915-1920).

LIST OF MEMBERS, 1921.

Ordinary Members.

1905 Allen, Edmund, c/o Resident Engineer, Yeulba, Queensland.
1906 Anderson, Charles, M.A., D.Sc., Australian Museum, College St., Sydney.
1921 Anderson, Miss Grace, B.Sc., Park Avenue, Gordon.
1899 Andrews, Ernest Clayton, B.A., F.G.S., Geological Survey, Department of Mines, Sydney.
1912 Aurousseau, Marcel, B.Sc., c/o Geo-Physical Laboratory, Carnegie Institution of Washington, Washington, D.C., U.S.A.

1913 Badham, Charles, B.Sc., M.B., Kendall, N.S.W.
1888 Baker, Richard Thomas, The Avenue, Cheltenham.
1919 Barnett, Marcus Stanley, c/o Colonial Sugar Refining Co., Ltd., O'Connell Street, Sydney.
1907 Benson, Professor William Noel, B.A., D.Sc., F.G.S., University of Otago, Dunedin, N.Z.
1911 Bickford, Ernest I., F.L.S., "Locksley," Greville Street, Randwick.
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1914 Bretnall, Reginald Wheeler, Australian Museum, College Street, Sydney.
1912 Brewster, Miss Agnes, Girls' High School, Sydney.
1900 Broelemann, Henry W., Boite 22, a Pau (Basses-Pyrenees), France.
1919 Broughton, Miss Eileen Marjorie, B.Sc., "Riverview," Glenfield, N.S.W.
1911 Browne, William Rowan, B.Sc., Geology Dept., University of Sydney.
1920 Burkitt, Arthur Neville St. George Handcock, M.B., B.Sc., Medical School, University of Sydney.
1921 Burns, Alexander Noble, "Roslyn," Salisbury Road, Rose Bay.
1910 Burrell, Harry, 19 Doncaster Avenue, Kensington.
1910 Burrell, Mrs. Harry, 19 Doncaster Avenue, Kensington.

1912 Cadell, Miss Myall, "Barcoo," Balala P.O., via Uralla, N.S.W.
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1899 Carne, Joseph Edmund, F.G.S., Dickson Avenue, Strathfield.
1905 Carne, Walter Mervyn, Hawkesbury Agricultural College, Richmond, N.S.W.
1890 Carson, Duncan, c/o Winchcombe, Carson, Ltd., Bridge St., Sydney.
1903 Carter, H. J., B.A., F.E.S., "Garrawillah," Kintore St., Wahroonga.
1912 Cayzer, Albert, B.Sc., University of Queensland, Brisbane, Q.
1904 Chapman, Professor Henry G., M.D., B.S., Medical School, University of Sydney.
1921 Chase, Miss Eleanor Emily, B.Sc., Zoology Department, The University, Sydney.
1899 Cheel, Edwin, Botanic Gardens, Sydney.
1920 Clarke, Harry Flockton, c/o Colonial Sugar Refining Co., Ltd., O'Connell St., Sydney.
1901 Cleland, Professor John Burton, M.D., Ch.M., The University, Adelaide, S.A.
1916 Collins, Miss Marjorie Isabel, B.Sc., Macleay Museum, The University, Sydney.
1908 Cotton, Leo Arthur, M.A., D.Sc., Geology Dept., University of Sydney.
1900 Crago, W. H., M.D., 185 Macquarie Street, Sydney.

1920 Danes, Dr. Jiri Victor, Consul-General of the Czechoslovak Republic, 40 Bayswater Road, Darlinghurst.
1885 David, Sir Tannatt William Edgeworth, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S., University of Sydney.
1883 Deane, Henry, M.A., F.L.S., M.Inst.C.E., "Campsie," 14 Mercer Road, Malvern, Melbourne, Victoria.
1916 Deer, Miss Margaret, B.A., B.Sc., 37 Milson Road, Watersleigh.
1913 Dixon, Jacob Robert L., M.R.C.S., L.R.C.P., Medical School, University of Sydney.
1887 Dixson, Sir Hugh, K.B., J.P., "Abergeldie," Summer Hill.
1881 Dixson, Thomas Storie, M.B., Ch.M., 215 Macquarie Street, Sydney.
1921 Dodd, Alan Parkhurst, Gordonvale, via Cairns, Queensland.
1918 Dodd, Frederick Parkhurst, Kuranda, North Queensland.
1894 Dun, William S., Department of Mines, Sydney.
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1920 Elston, Albert H., F.E.S., 50 Lefevre Terrace, North Adelaide, S.A.
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1908 Finckh, Herman E., "Hermes," 100 Raglan Street, Mosman.
1881 Fletcher, Joseph J., M.A., B.Sc., Woolwich Road, Woolwich.
1908 Flynn, Professor Theodore Thomson, D.Sc., University of Tasmania, Hobart, Tas.
1920 Friend, Norman Bartlett, 42 Pile Street, Dulwich Hill.
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1886 Froggatt, Walter Wilson, F.L.S., Agricultural Museum, George St. North, Sydney.
1920 Furst, Herbert Charles, Linwood Avenue, Killara.

1915 Gilder, Percy George, c/- Sydney Morning Herald, Pitt St., Sydney.
1912 Goldfinch, Gilbert M., "Lyndhurst," Salisbury Road, Rose Bay.
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1911 Greenwood, William Frederick Neville, c/- Colonial Sugar Refining Co., Ltd., Lautoka, Fiji.
1910 Griffiths, Edward, B.Sc., Dept. of Agriculture, 136 Lower George St., Sydney.
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1911 Hacker, Henry, Queensland Museum, Bowen Park, Brisbane, Q.
1909 Hall, E. Cuthbert, M.D., Ch.M., George Street, Parramatta.
1919 Hall, Leslie Lionel, Kareela Road, Cremorne.
1897 Halligan, Gerald H., F.G.S., Avenue Road, Hunter's Hill.
1915 Hamblin, Charles Oswald, B.Sc., "Glengarth," 51 West Street, Petersham.
1899 Hamilton, Arthur Andrew, Botanic Gardens, Sydney.
1885 Hamilton, Alexander Greenlaw, "Tanandra," Hercules Street, Chatswood.
1917 Hardy, G. H. Hurlestone, "Mullwarrie," Beach Road, Rushcutter's Bay.
1905 Harrison, Launcelot, B.Sc., B.A., Zoology Dept., University of Sydney.
1879 Haswell, Professor William Aitcheson, M.A., D.Sc., F.R.S., "Mimihau," Woollahra Point.
1911 Haviland, The Venerable Archdeacon F. E., The Rectory, Coonamble, N.S.W.
1891 Hedley, Charles, F.L.S., Australian Museum, College St., Sydney.
1920 Henry, Marguerite, B.Sc., "Derwent," Oxford St., Epping.
1909 Henry, Max, D.S.O., M.R.C.V.S., B.V.Sc., Coram Cottage, Essex Street, Epping.
1913 Hill, Gerald F., F.E.S., c/- Australian Institute of Tropical Medicine, Townsville, Queensland.
1916 Hinder, Miss Eleanor Mary, B.Sc., "Taverham," Bridge End Street, Wollstonecraft.
1916 Hindmarsh, Miss Ellen Margaret, B.Sc., Medical School, The University of Sydney.

1918 Hopson, John, Jr., "Dalkeith," Eccleston, N.S.W.
1907 Hull, Arthur Francis Basset, Box 704, G.P.O., Sydney.
1892 Hynes, Miss Sarah, B.A., "Isis," Soudan Street, Randwick.

1912 Irby, Llewellyn George, Forest Branch, Lands Dept., Hobart, Tasmania.

1912 Jackson, Sidney William, M.R.A.O.U., Belltrees, via Scone, N.S.W.
1917 Jacobs, Ernest G., "Maranta," Henry Street, Ashfield.
1903 Jensen, Harald Ingemann, D.Sc., Queensland Geological Survey, George St., Brisbane. Q.
1907 Johnston, Professor Thomas Harvey, M.A., D.Sc., University of Queensland, Brisbane, Q.

1921 Kennedy, John A., M.B., Ch.M., 423 Marrickville Road, Dulwich Hill.

1913 Lawson, Professor A. Anstruther, D.Sc., F.R.S.E., Botany Dept., University of Sydney.
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1910 Le Souef, A. S., C.M.Z.S., Zoological Gardens, Taronga Park, Mosman.
1911 Longman, Heber A., Queensland Museum, Bowen Park, Brisbane, Q.
1891 Lower, Oswald B., F.E.S., Bartley Crescent, Wayville, S.A.
1893 Lucas, A. H. S., M.A., B.Sc., Sydney Grammar School, College St., Sydney.

1919 McCarthy, T., Bertram Street, Mortlake.
1907 McCulloch, Allan Riverstone, Australian Museum, College Street, Sydney.
1907 McDonnough, Thomas, L. S., "Iluka," Hamilton Street, Randwick.
1917 McKeown, Keith Collingwood, Office of the Water Conservation and Irrigation Commission, Leeton, N.S.W.
1911 Mackinnon, Ewen, B.Sc., Commonwealth Institute of Science and Industry, 314 Albert Street, East Melbourne.
1883 Maiden, J. Henry, I.S.O., F.R.S., F.L.S., Botanic Gardens, Sydney.
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1884 Mitchell John, 10 High Street, Waratah, N.S.W.
1904 Murdoch, R., Wanganui, New Zealand.
1920 Musgrave, Anthony, Australian Museum, College St., Sydney.
1888 Musson, Charles T., "Kia-ora," Nelson Street, Gordon.

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1920 Noble, Robert Jackson, B.Sc. Agr., Carrington Street, Homebush.
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1920 O'Dwyer, Margaret Helena, B.Sc., Department of Agriculture, The University, Sydney.
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1908 Playfair, George Israel, 8th Avenue, Tauranga, New Zealand.
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1918 Priestley, Henry, M.D., B.Sc., Medical School, University of Sydney.
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1919 Scammell, George Vance, 18 Middle Head Road, Mosman.
1918 Sherrie, Miss Heather, B.Sc., Ben Boyd Road, Neutral Bay.
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1907 Taylor, Frank H., c/- Box 137, G.P.O., Sydney.
1920 Tebbutt, Arthur Hamilton, M.B., 185 Macquarie Street, Sydney.
1916 Tilley, Cecil Edgar, B.Sc., Geology Dept., University of Sydney.
1904 Tillyard, Robin John, D.Sc., M.A., F.L.S., F.E.S., C.M.Z.S., Cawthron Institute, Nelson, New Zealand.
1921 Troughton, Ellis Le Geyt, Australian Museum, College Street, Sydney.
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1892 Wilson, Professor James T., M.B. Ch.M., F.R.S., Department of Anatomy, The New Museums, Cambridge, England.
1903 Woolnough, Walter George, D.Sc., F.G.S., University of Sydney.
1910 Wymark, Frederick, 89 Castlereagh Street, Sydney.

Honorary Members.

1897 De Toni, Dr. G. B., R. Orto Botanico di Modena, Italy.

Corresponding Members.

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1884 Bell, Professor F. Jeffrey, M.A., British Museum (Natural History), Cromwell Road, London, S.W. 7., England.
1902 Broom, Robert, M.D., D.Sc., F.R.S., Douglas, Cape Colony, South Africa.

1902 McAlpine D., Government Vegetable Pathologist, Dept. of Agriculture, Melbourne, Victoria.
1902 Meyrick, Edward, B.A., F.R.S., F.Z.S., Thornhanger, Marlborough, Wilts., England.

1888 Pearson, W. H.

1901 Raffray, A., Consulat General de France, 6 Piazza Madama, Rome, Italy.

Sanger, E. B.
1893 Spencer, Professor Sir W. Baldwin, K.C.M.G., D.Sc., F.R.S., The University, Melbourne, Victoria.

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(1921).

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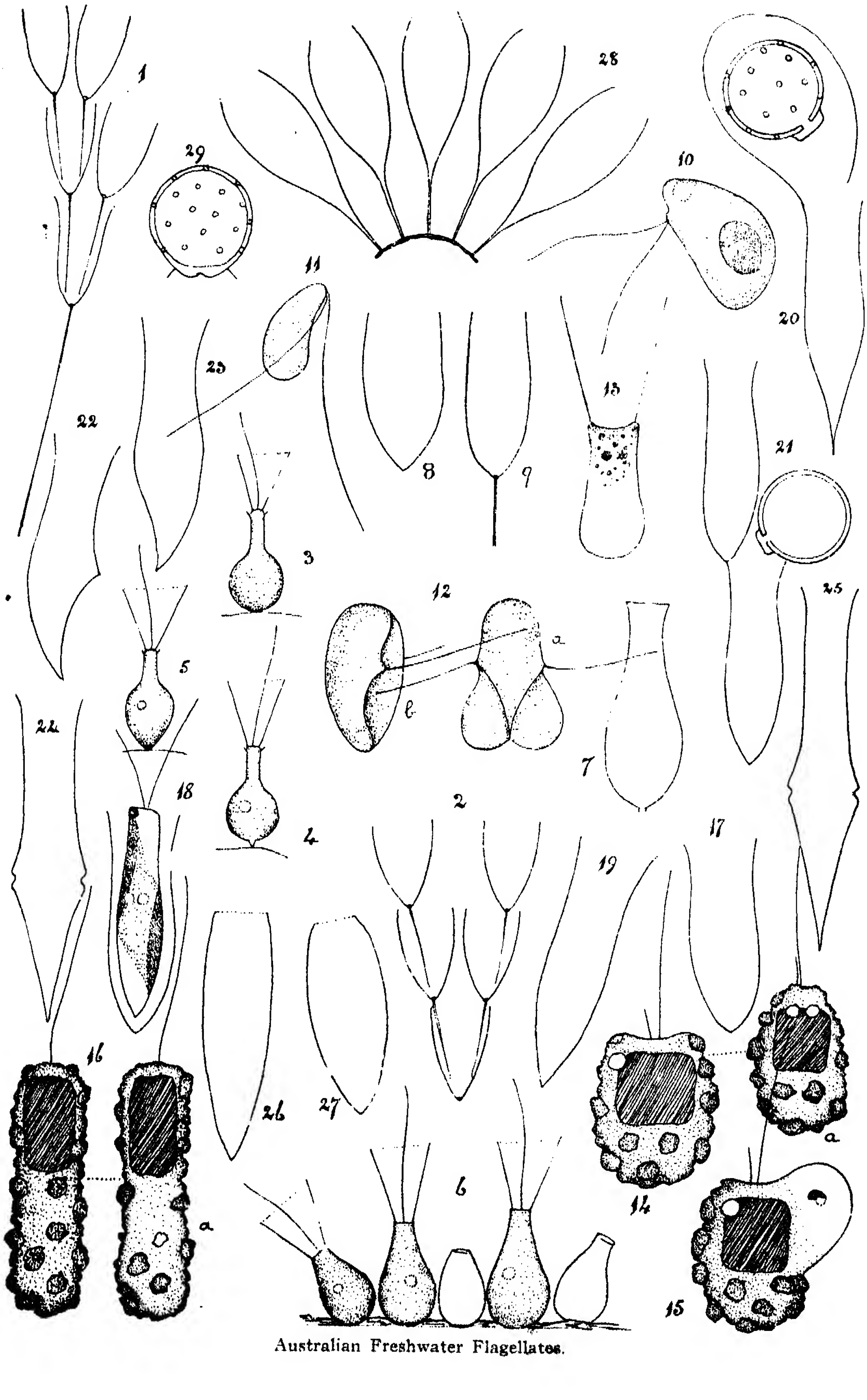
(b) BIOLOGICAL INDEX.

Synoyms are printed in *italics*; *new* names in SMALL CAPITALS.



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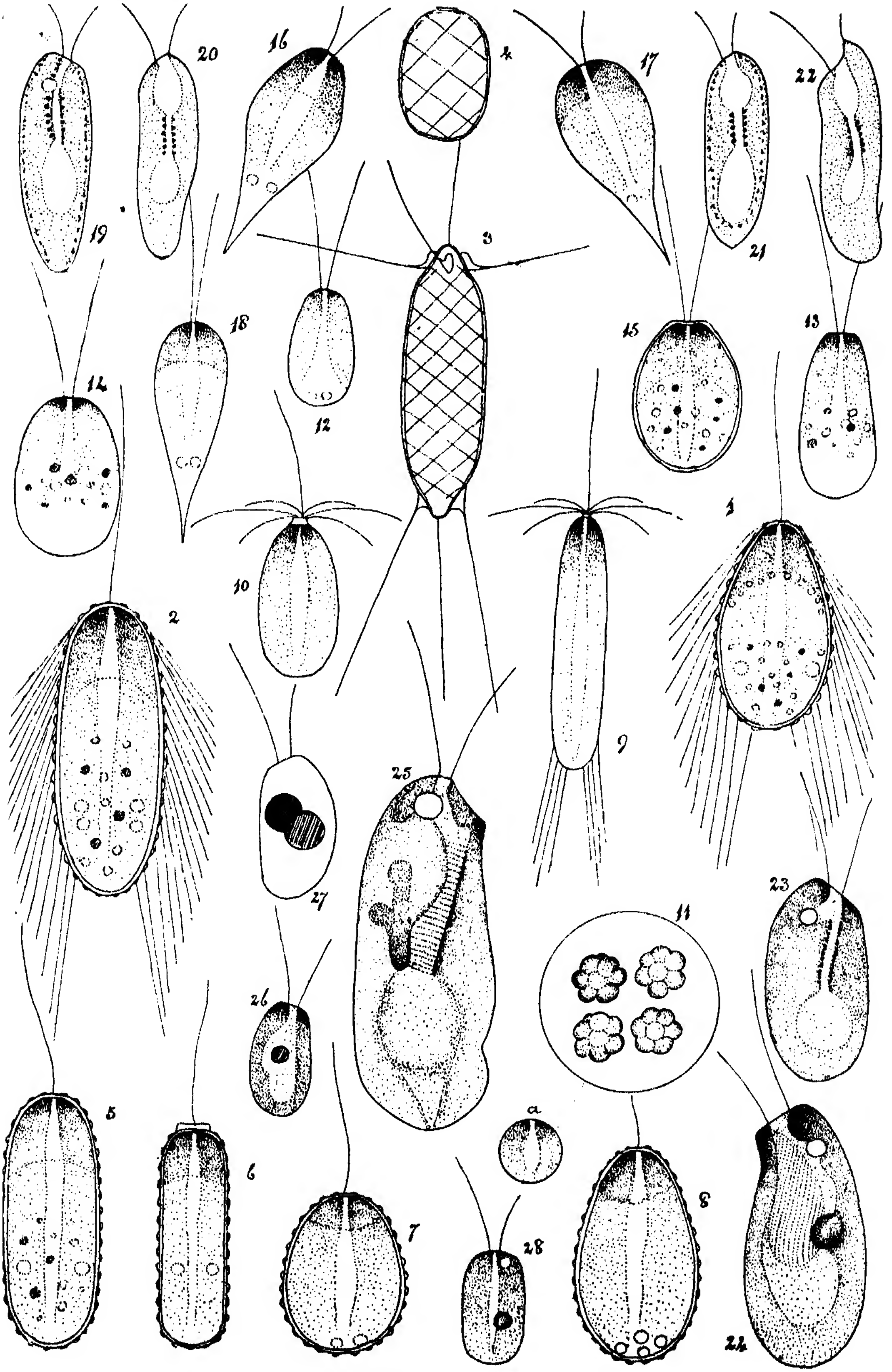

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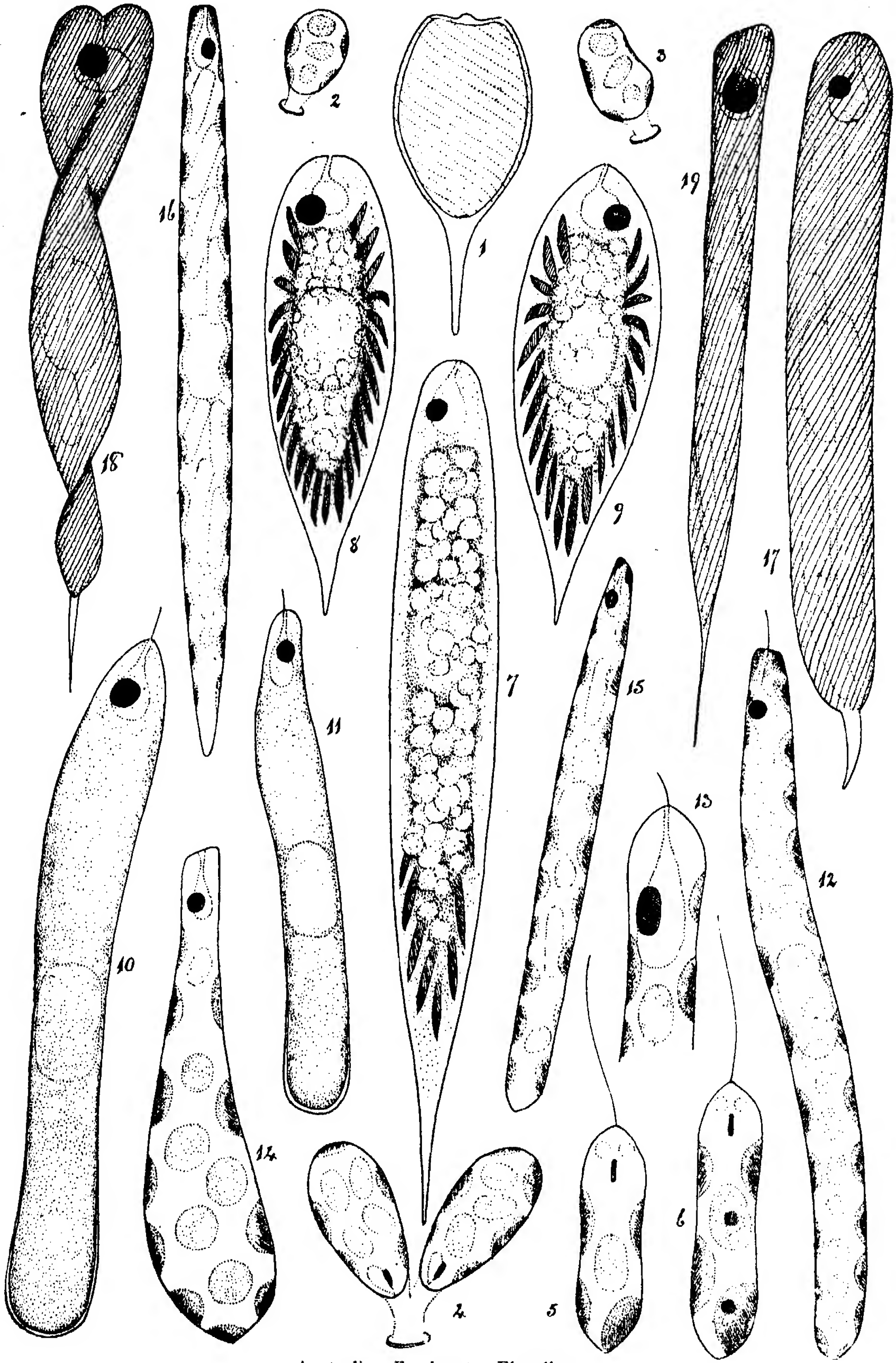

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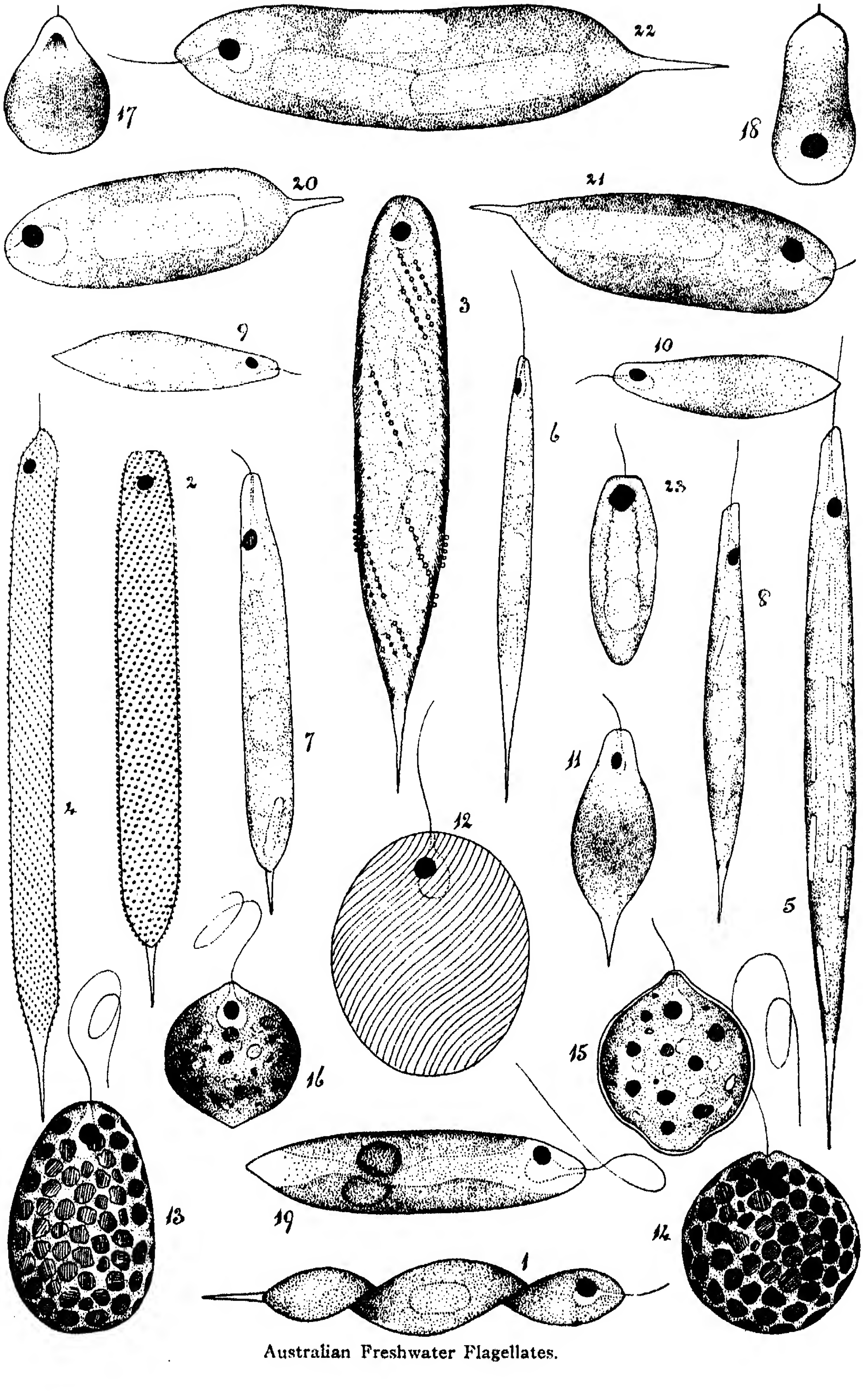

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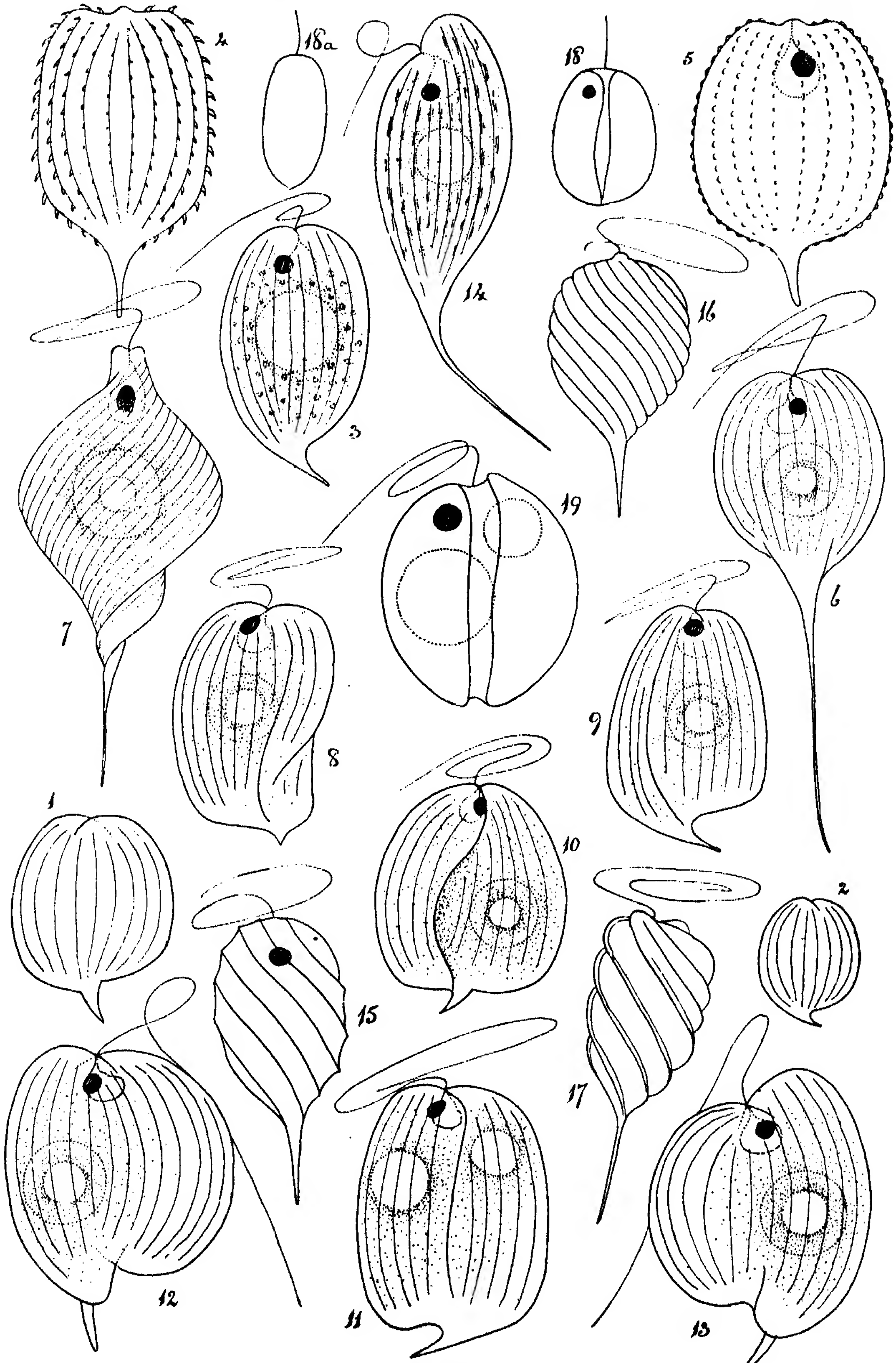

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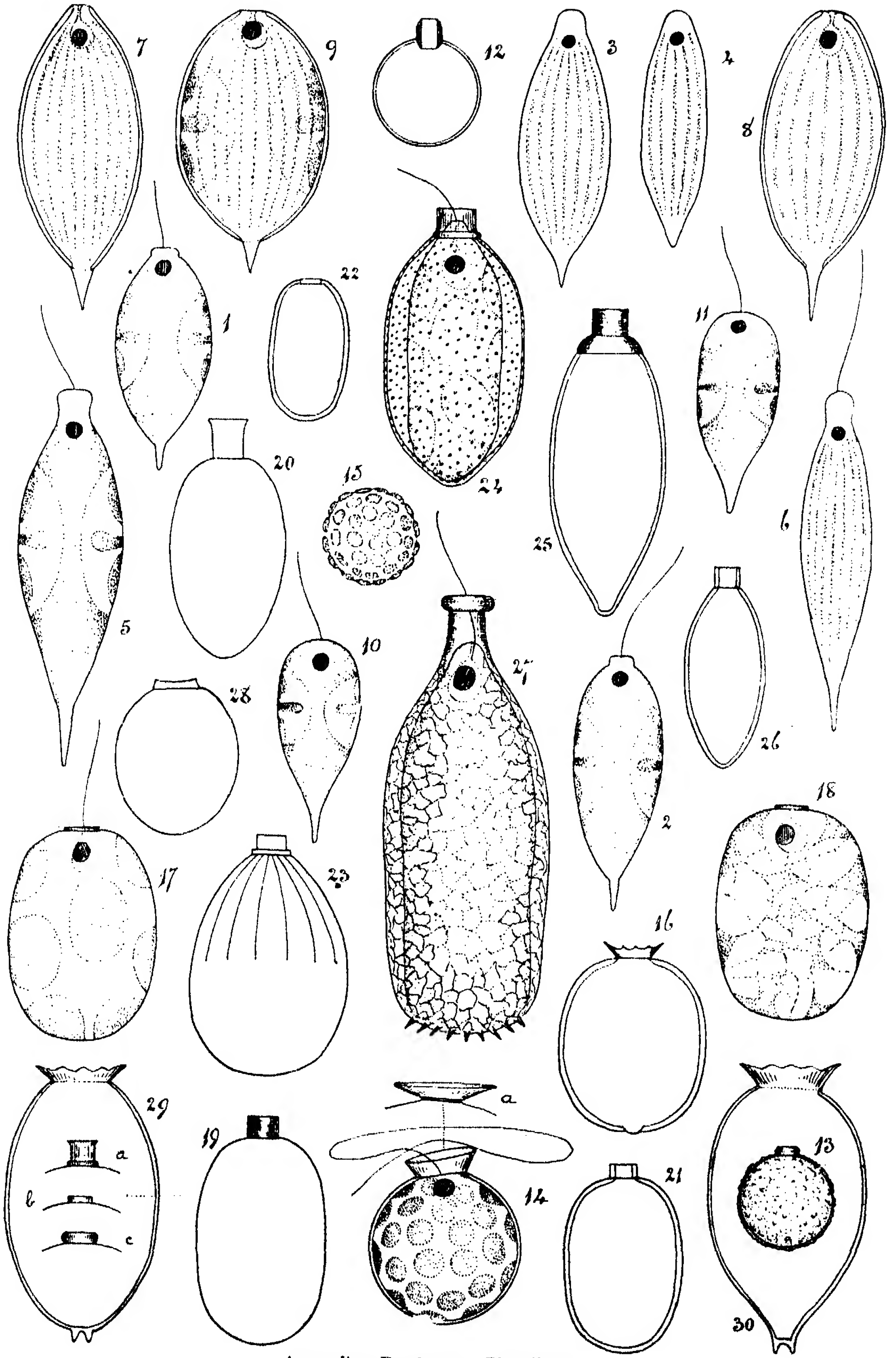

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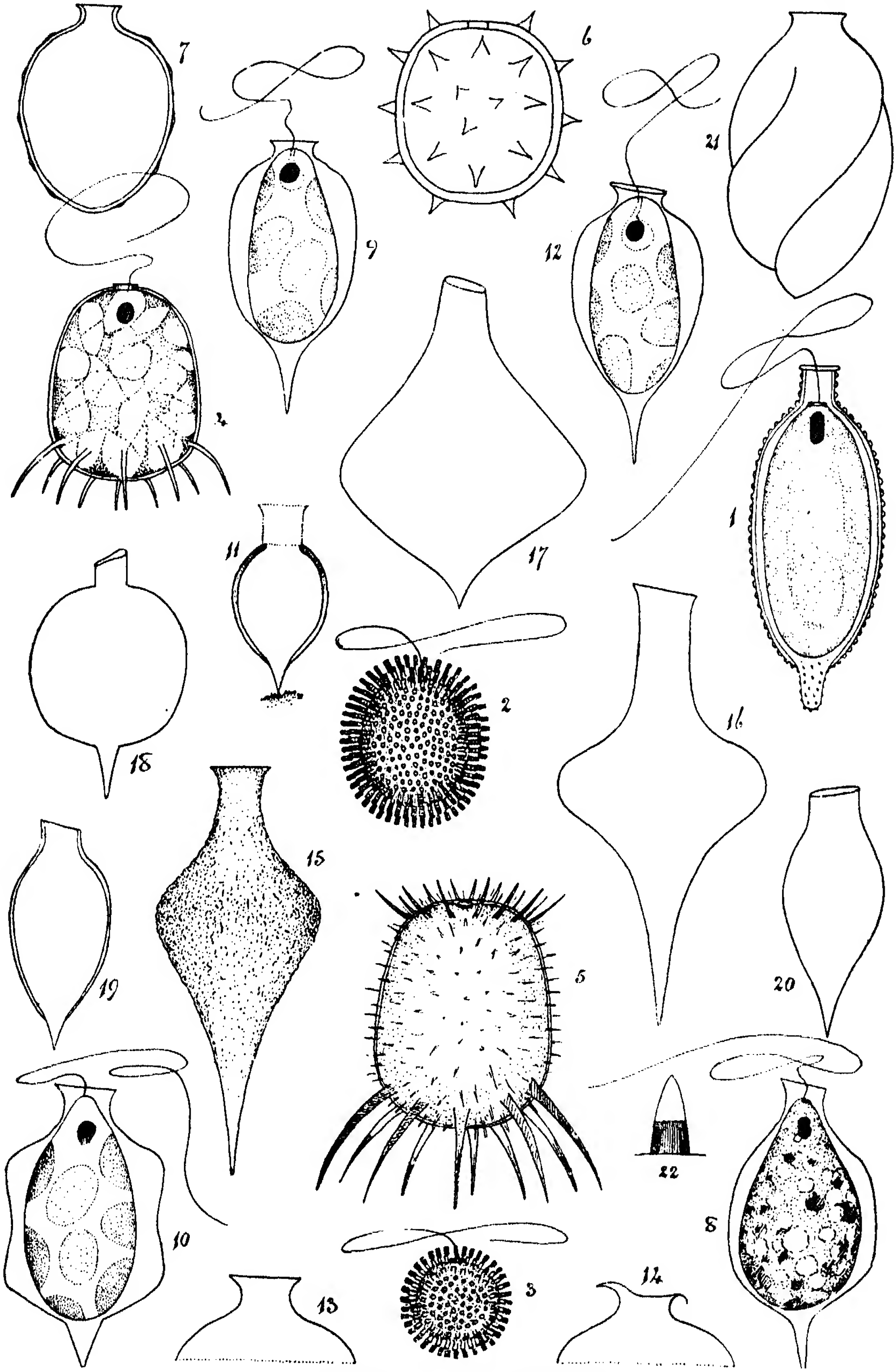

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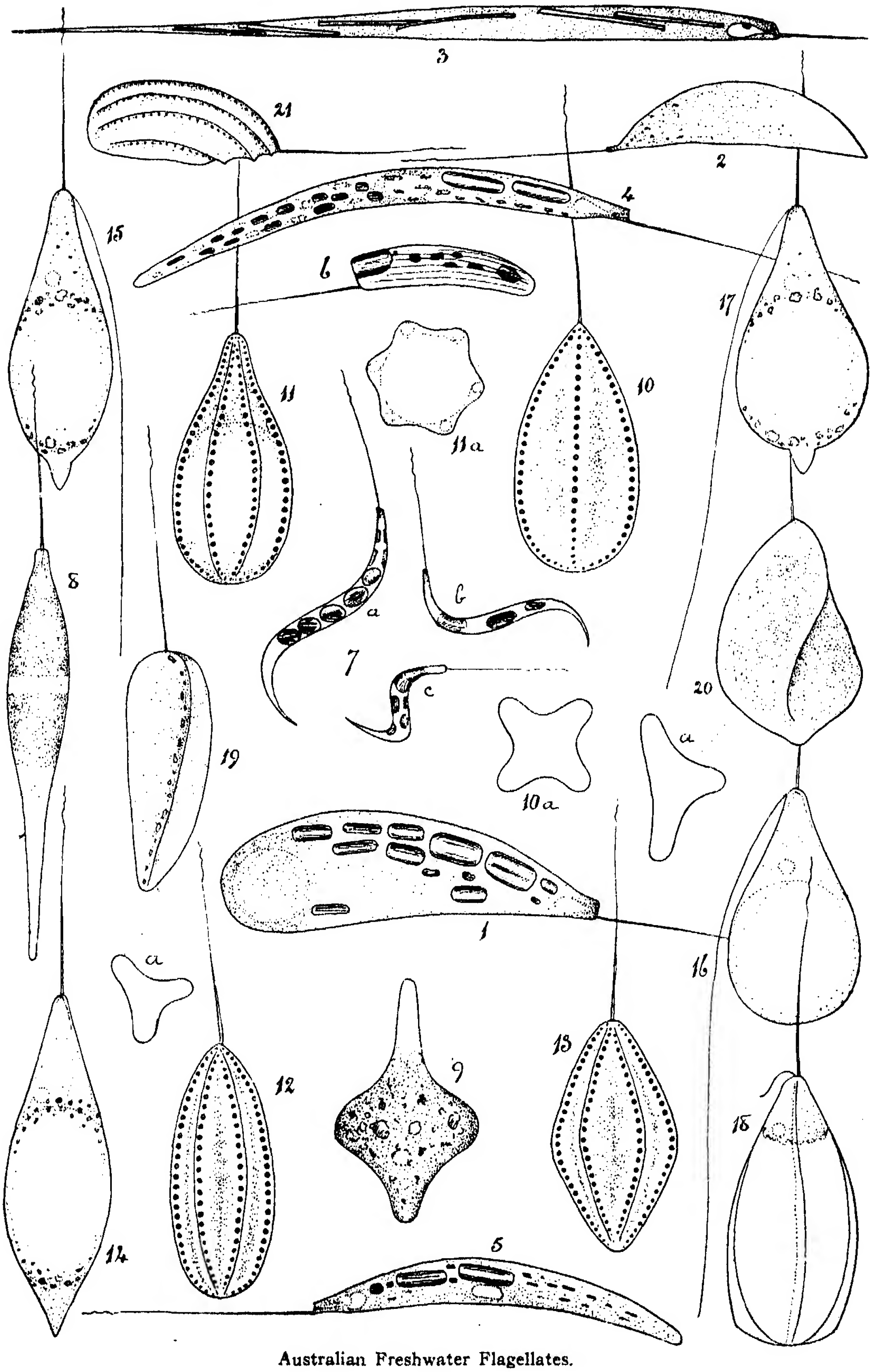

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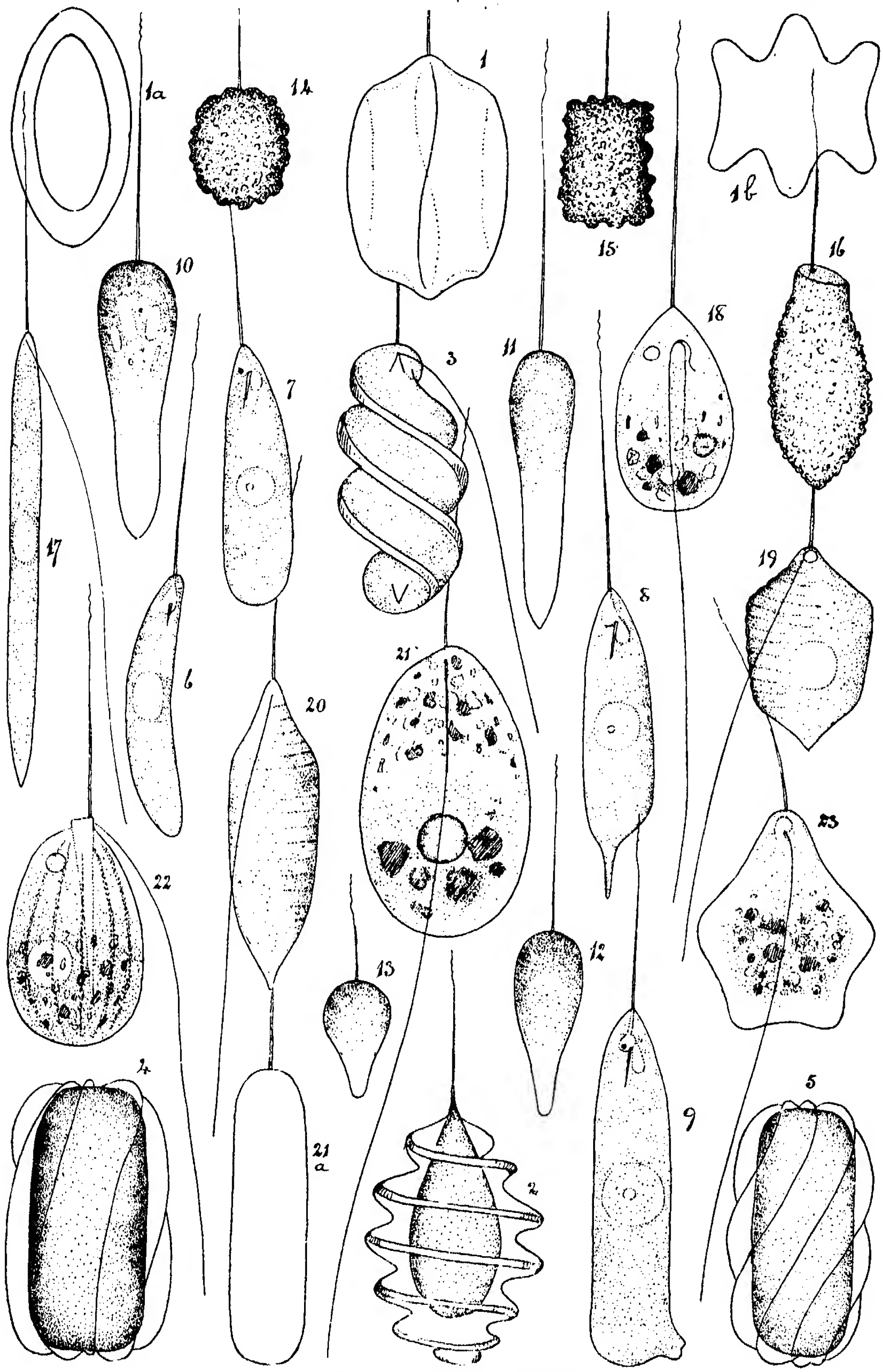

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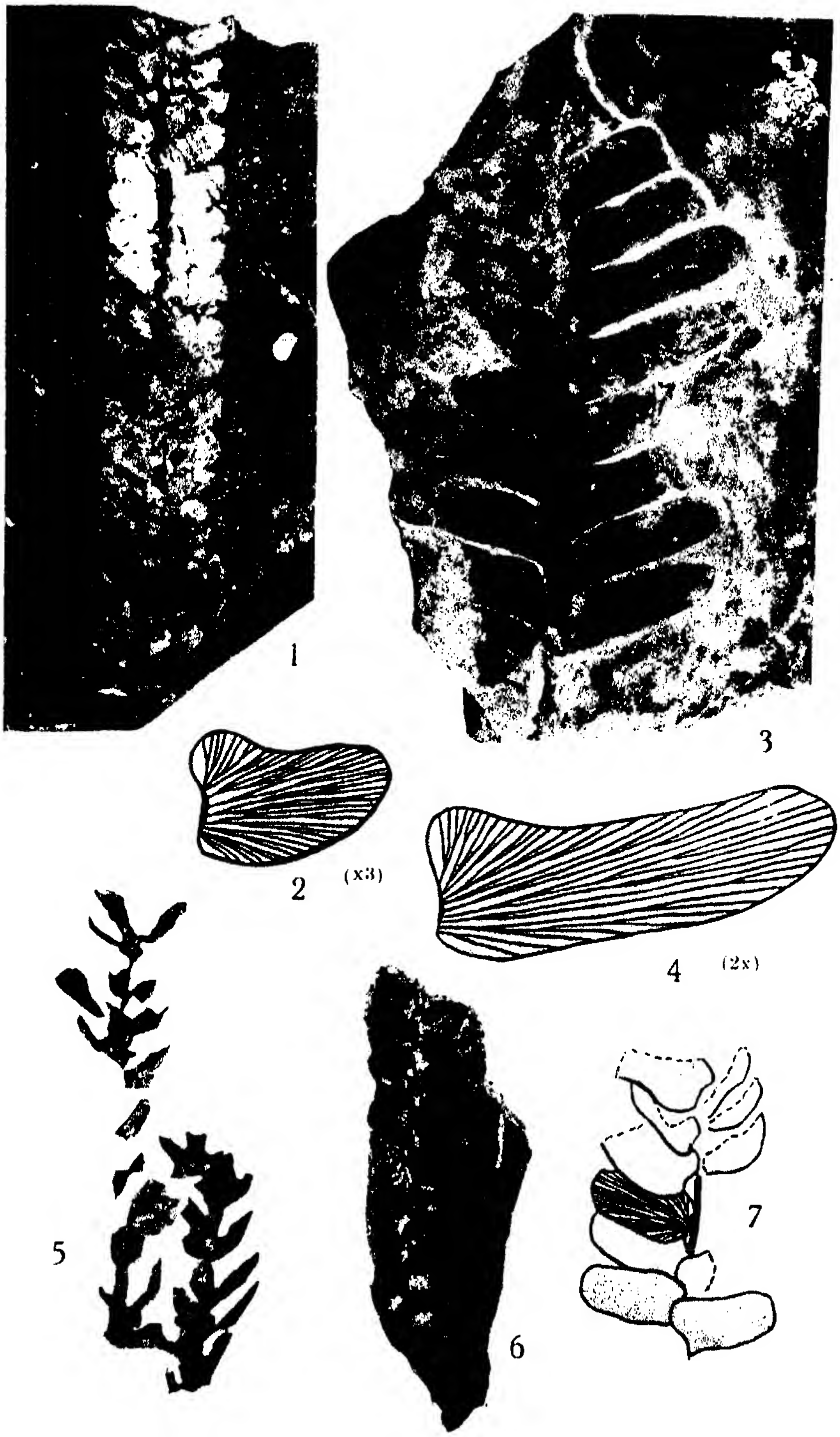
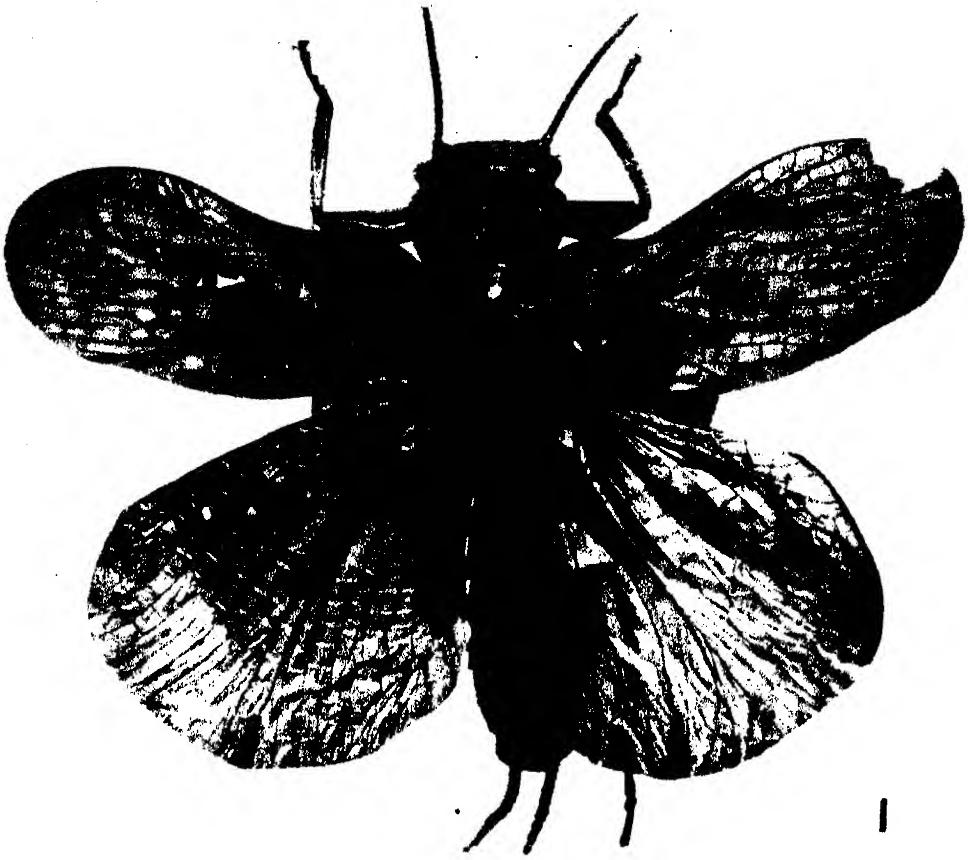


1, 2, 6. *Otozamites bengalensis.* 3, 4. *O. Bechei.* 7. *O. Feistmanteli.*
5. ?. *Pagiophyllum*, sp.



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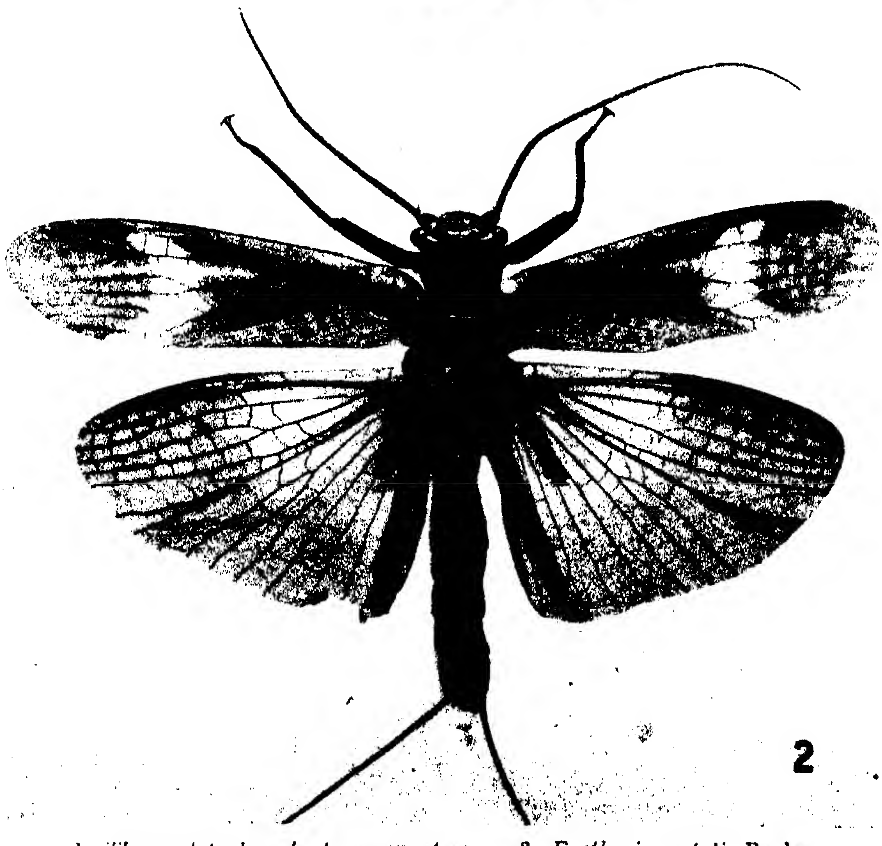

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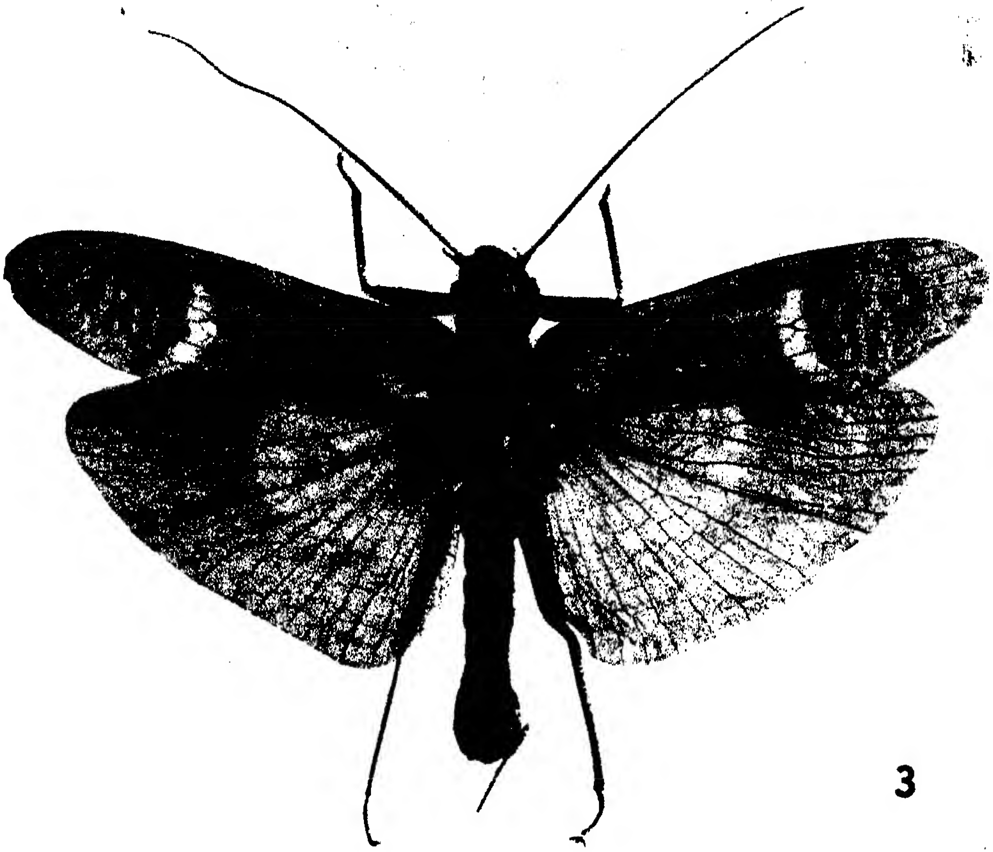
1. *Thaumatoperla robusta*, n.gen. et sp. 2. *Eusthenia costalis* Banks.



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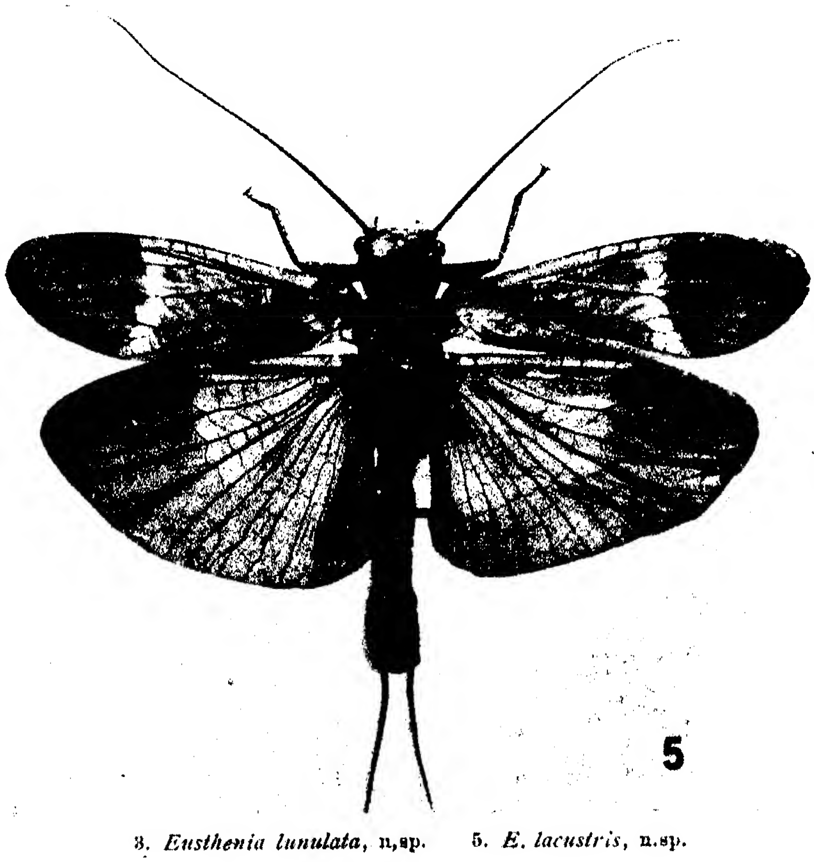

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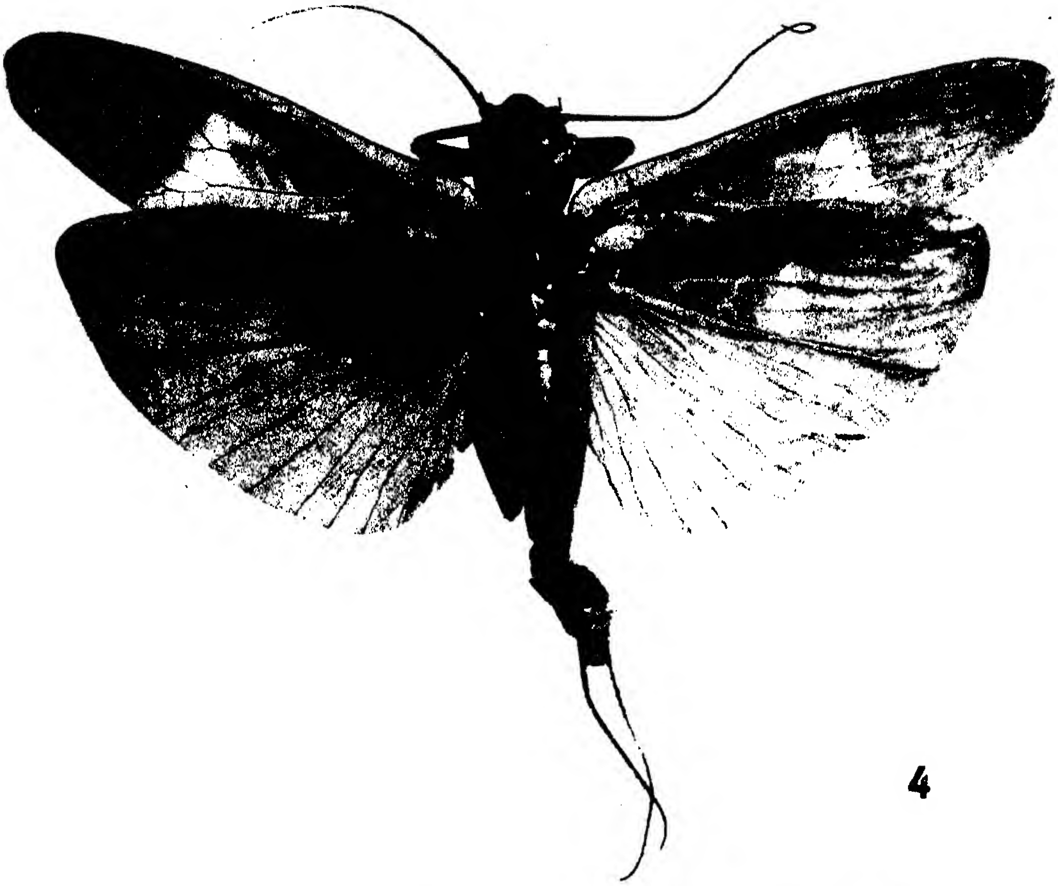
3. *Eusthenia lunulata*, n.sp. 5. *E. lacustris*, n.sp.



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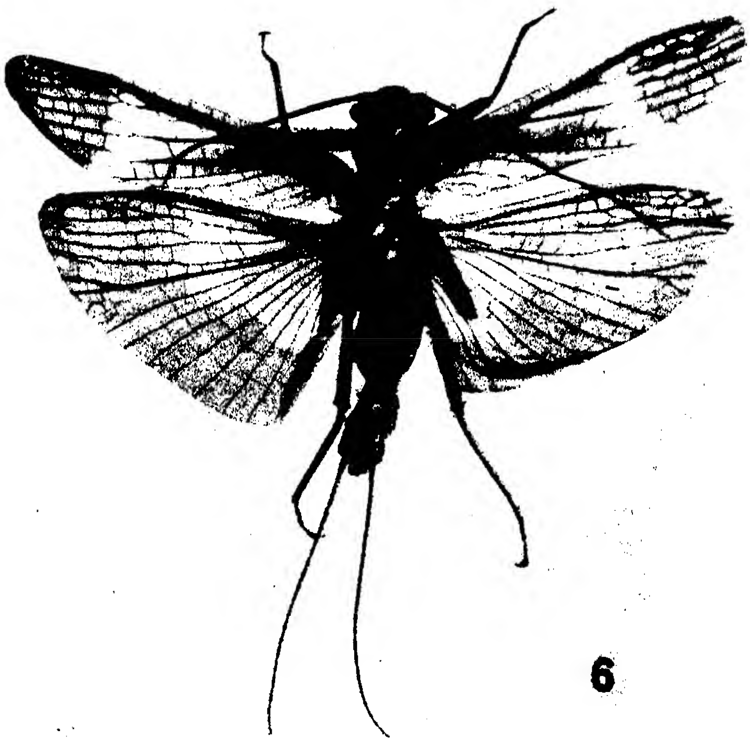

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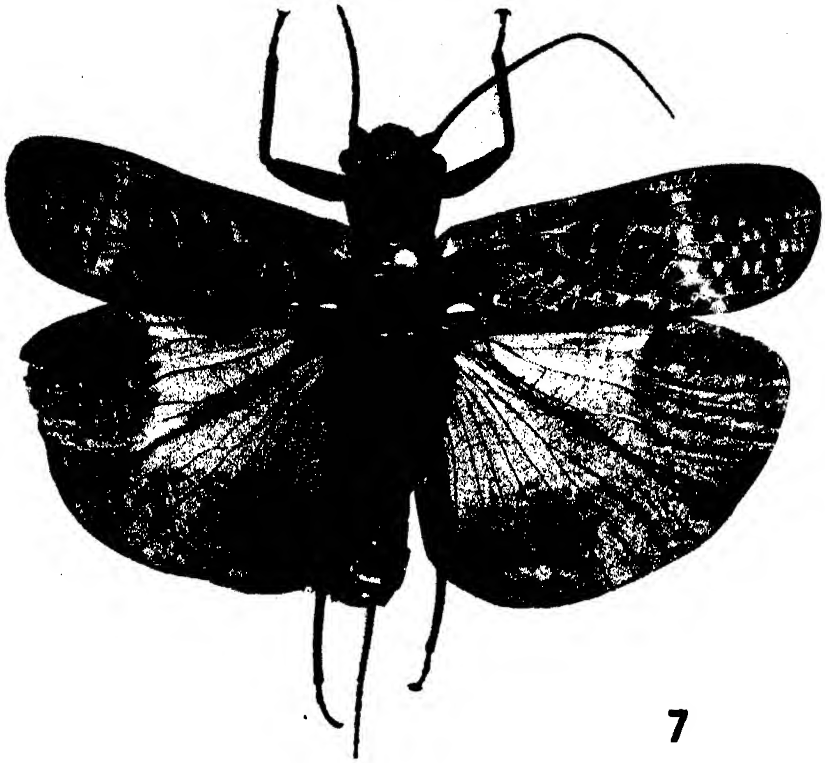
4. *Eusthenia spectabilis cuegnia*, n. subsp. 6. *E. purpurescens*, n.sp. ♂.



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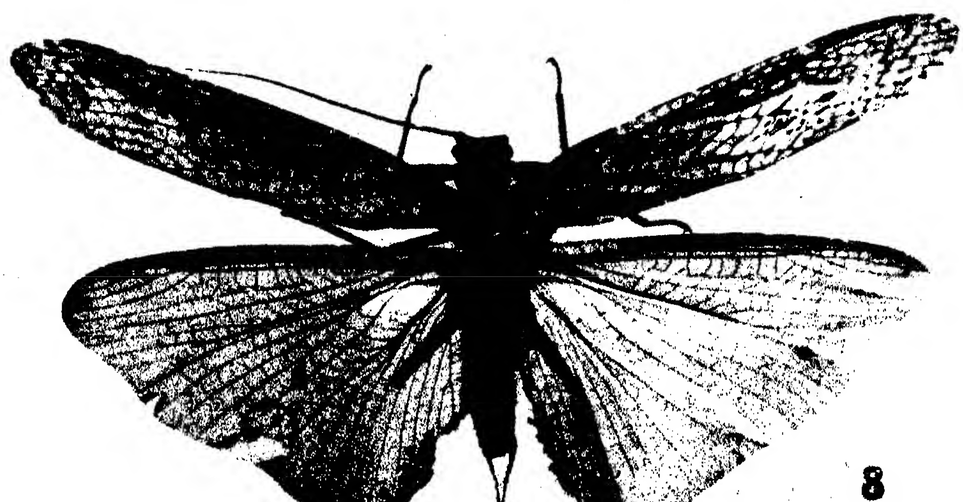

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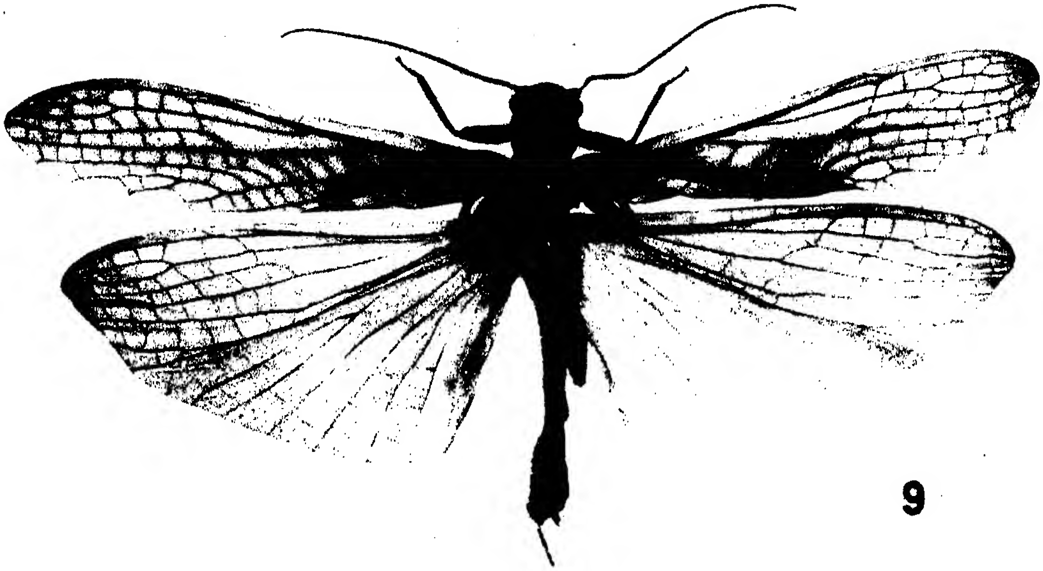
7. *Eustheniopsis venosa*, n. gen. et sp. 8. *Diamphipnoa annulata* (Brauer).



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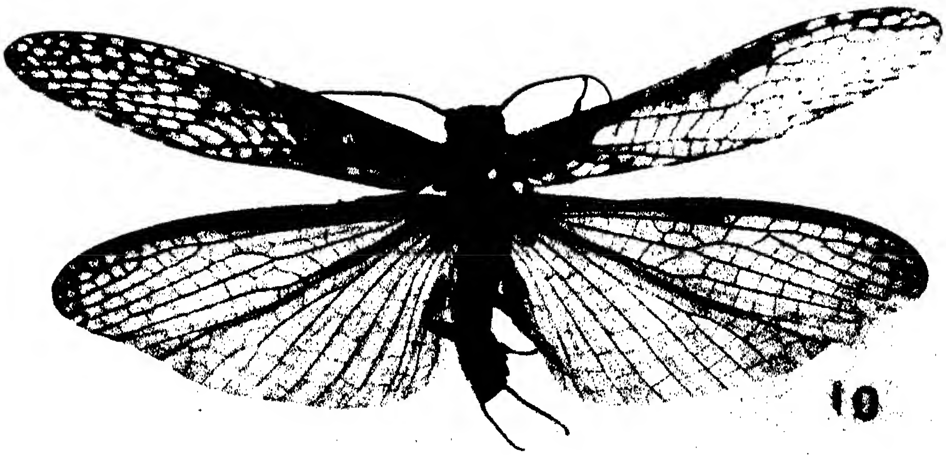

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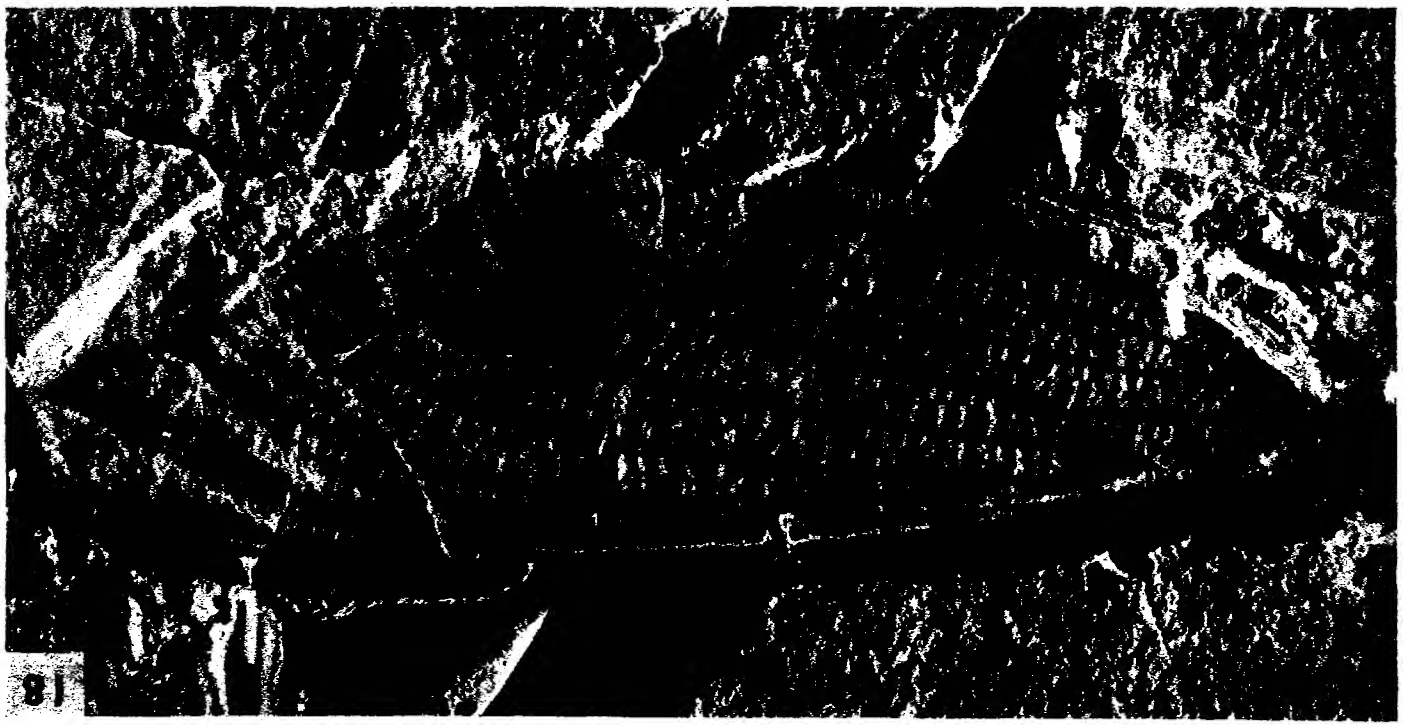
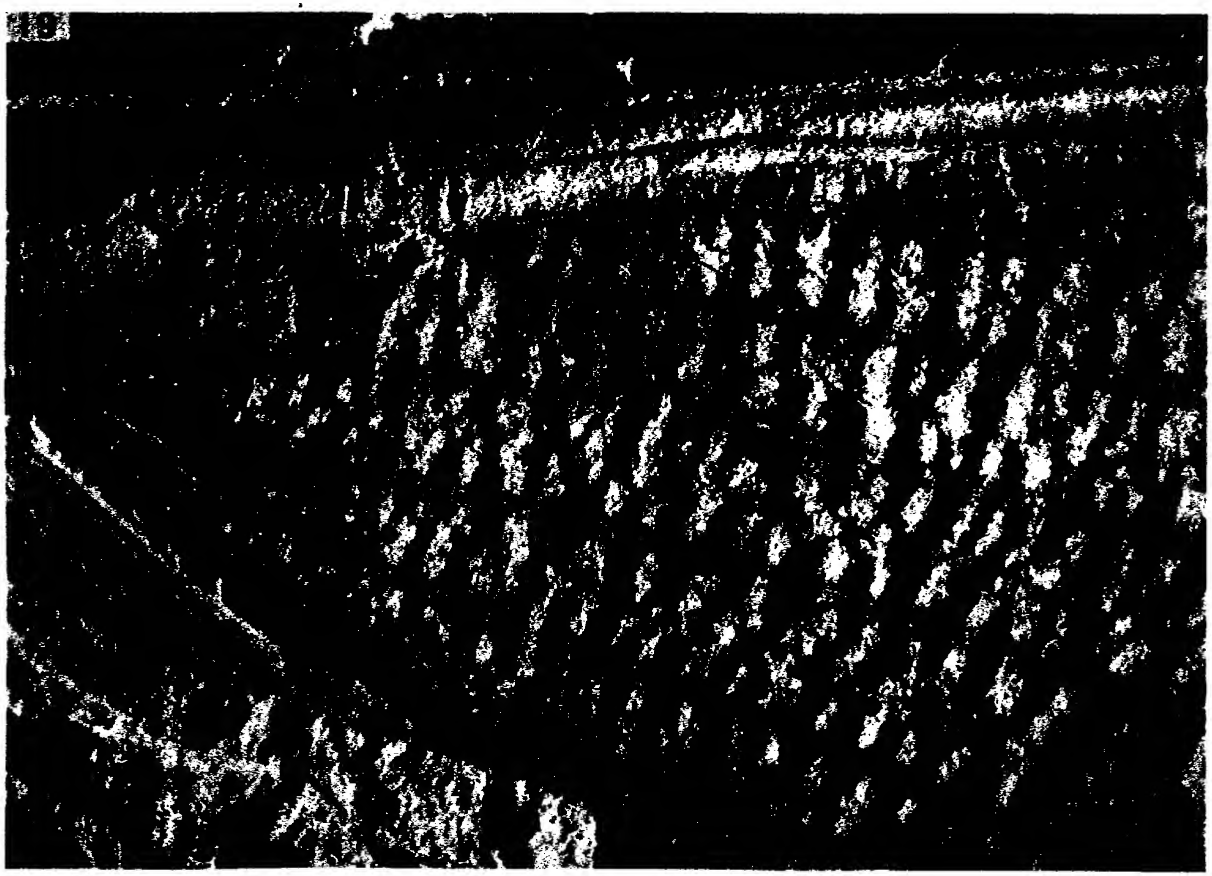
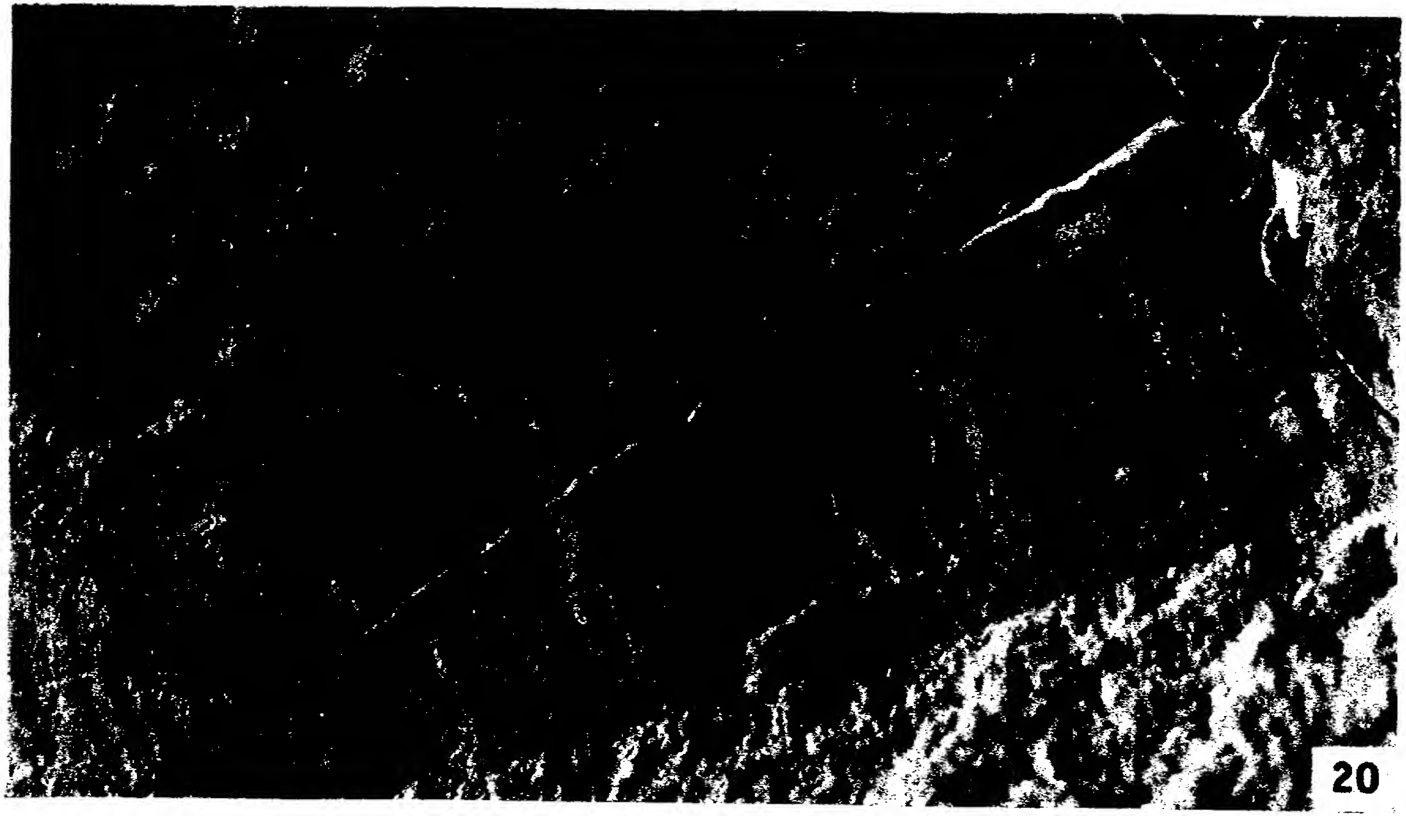
9. *Stenoperla prasina* (Newman). 10. *S. australis*, n.sp.



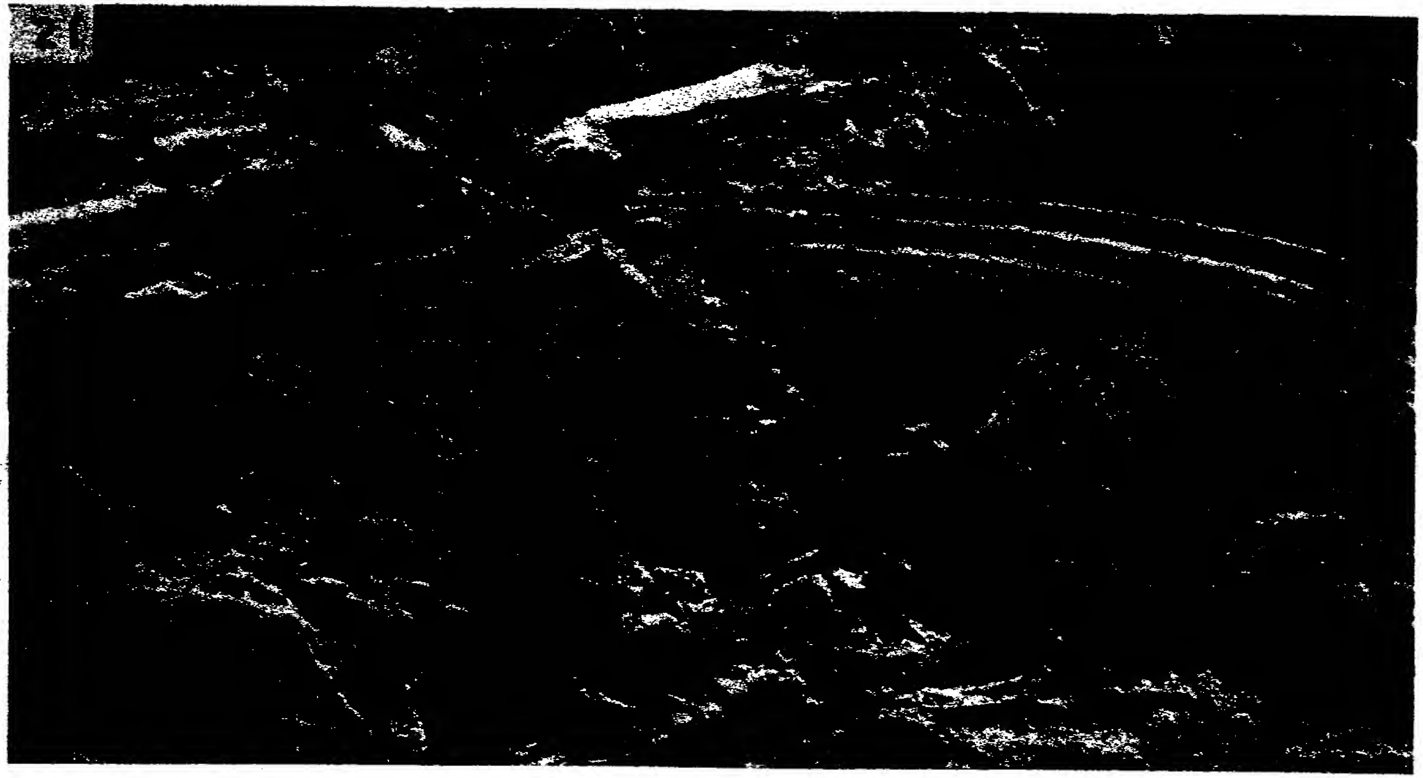
Mesogereon superbum, n.sp.



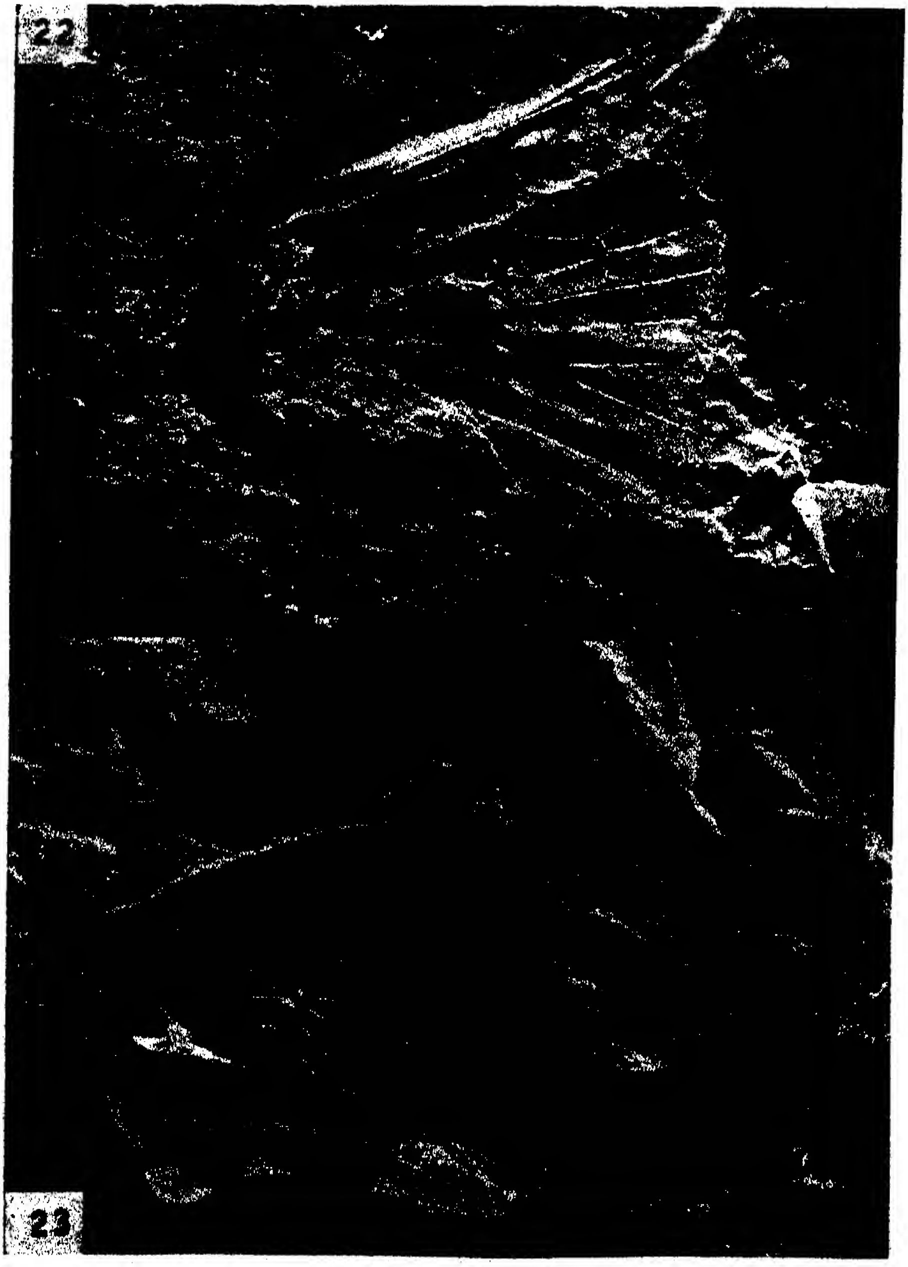
Mesogereon superbum, n.sp.



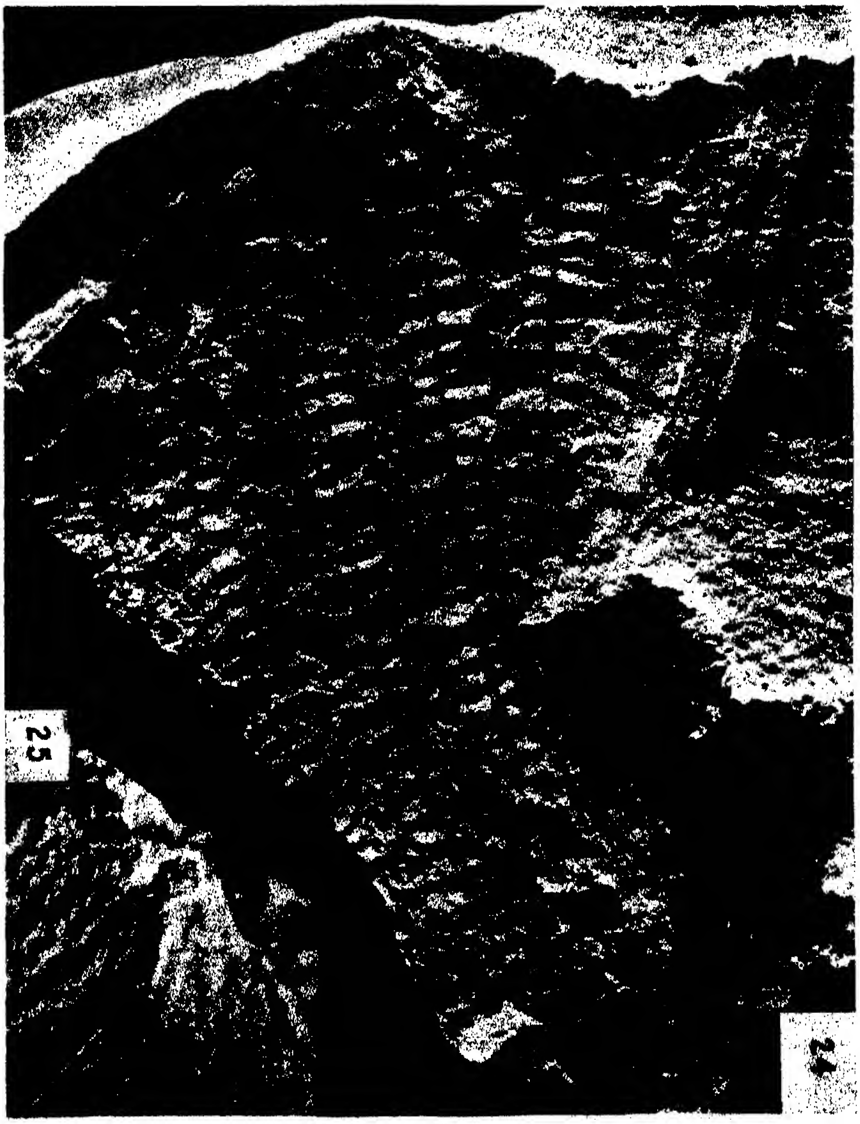
Mesogereon superbum, n.sp.



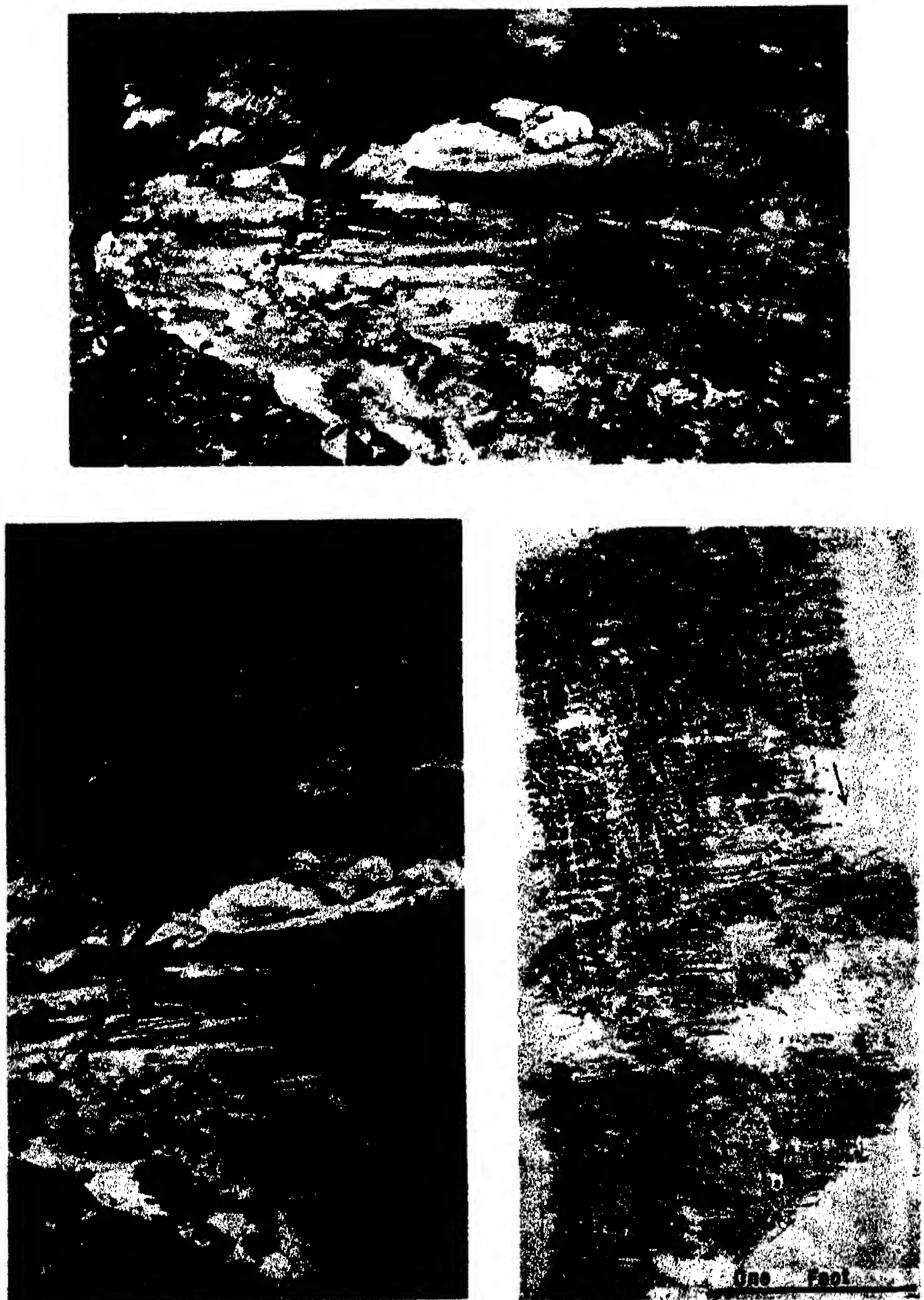
Mesogereon affine, n.sp.



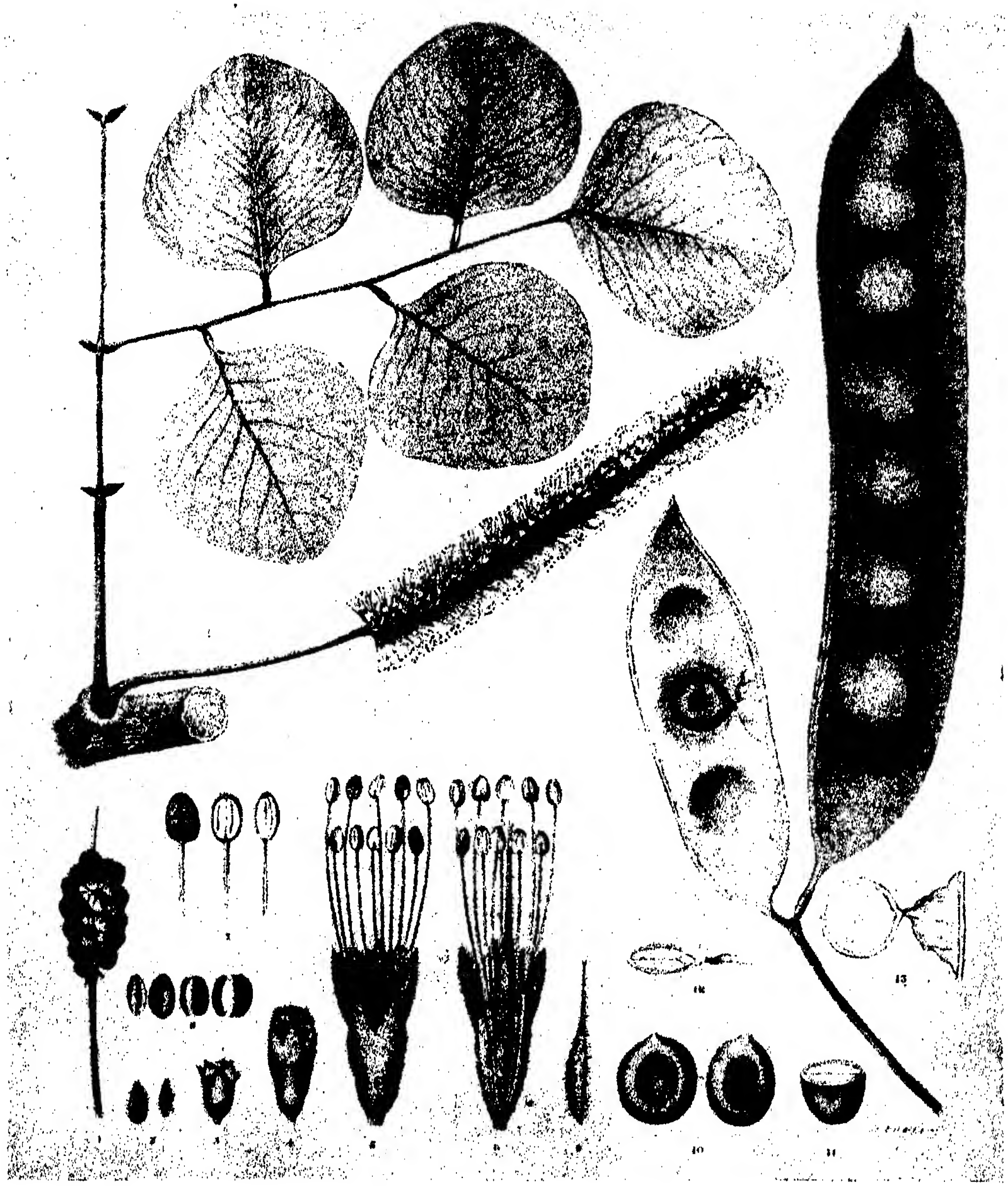
22. *Mesogereon affine*, n.sp. 23. *M. shepherdi*, n.sp.



24. *Mesogereon neuropunctatum* Tillyard. 25. *M. shepherdi*, n.sp.



Glacially-striated pavement in the Kuttung Series, New South Wales.



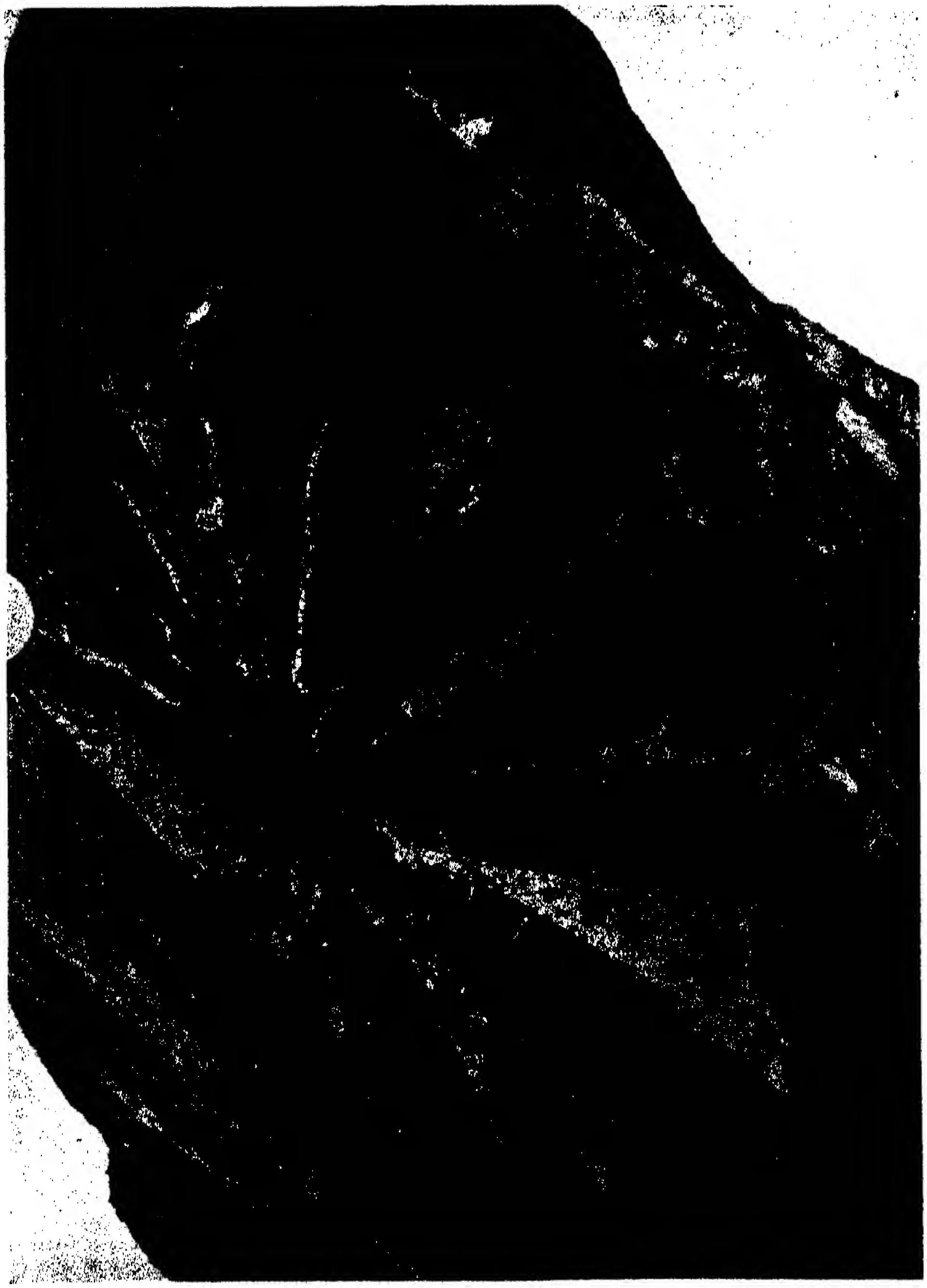
Erythrophloeum Laboucherii F. v. M.
(From the Queensland Agricultural Journal, Vol. vii., Pt. 2.)

Fig. 1.

Fig. 2.

Erythrophloeum Laboucherii F. v. M.

(From photo by C. ALLEN, ESQ., Curator of the Botanic Gardens, Darwin.)



Noeggerathiopsis Hislopi.

Photo 1.

Mangrove Formation at high tide, Middle Harbour, Port Jackson.

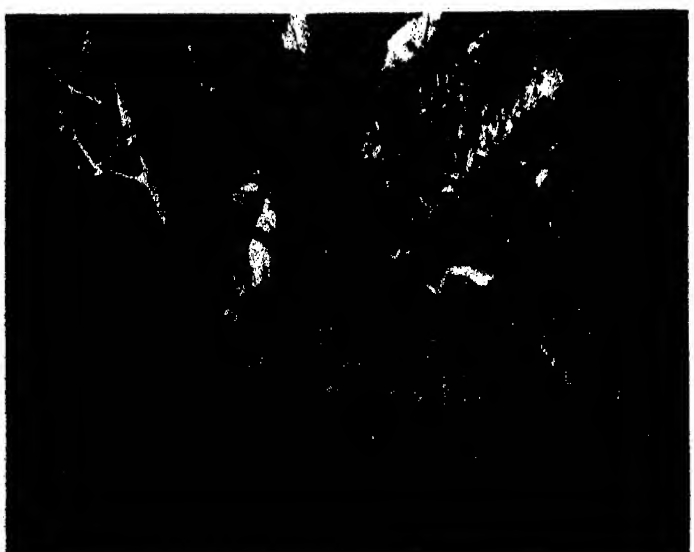


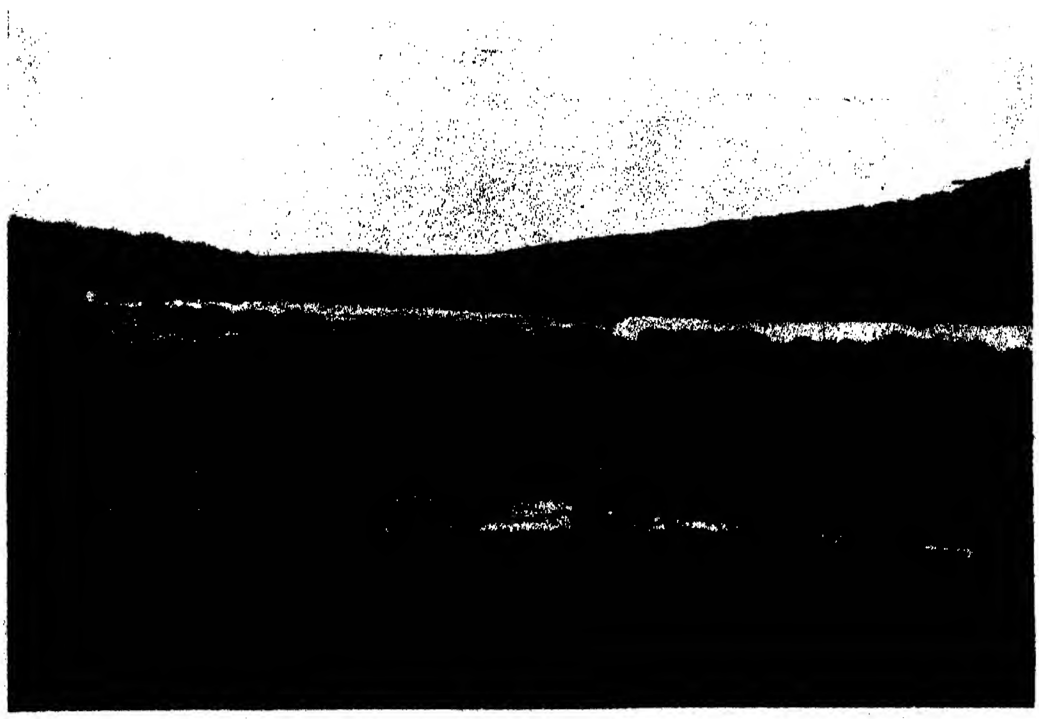
Photo 3.

Close view of *Avicennia officinalis* showing pneumatophores.

A. Musgrave, Photo.

A. Musgrave, Photo. Photo 2.

Interior of Mangrove Formation at Port Hacking.



D. A. Pritchard, Photo. Photo 4.

Cabbage Tree Creek, Port Hacking.

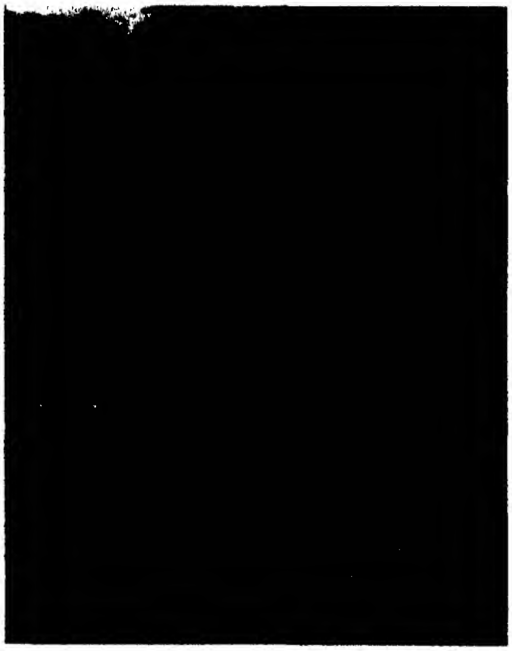


Photo 5.

Aegiceras majus, Port Hacking.

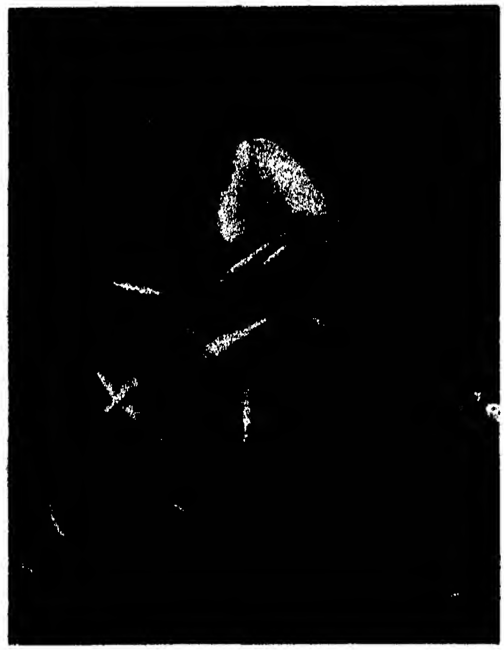


Photo 6.

Aegiceras majus, with cluster of viviparous fruits.

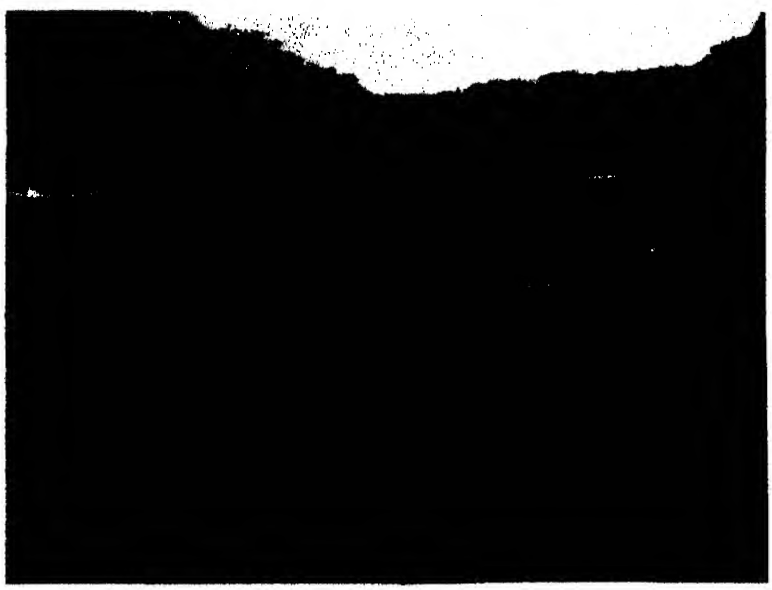


Photo 7.

Junction of *Sporobolus-Cynodon* and *Salicornia-Samolus* Associes, Middle Harbour.

A. Musgrave, Photo.

Photo 8.

Avicennia officinalis (tree) and low bushes of *Aegiceras majus*, Port Hacking.

Photo 9.

Avicennia officinalis and *Aegiceras majus* being buried in drift sand.

A. Musgrave, Photo.

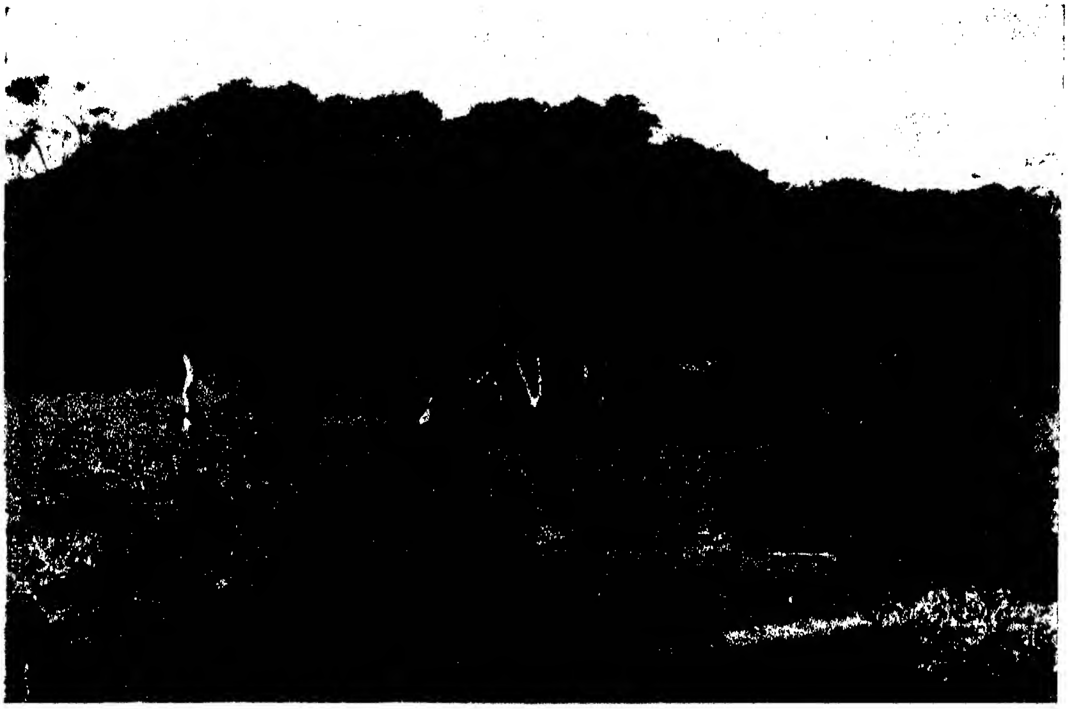


Photo 11.
Group of old trees of *Avicennia officinalis*, Cabbage Tree Creek, Port Hacking.

Photo 12.
Dwarf growth of *Avicennia officinalis*.

D. A. Pritchard, Photo.

D. A. Pritchard, Photo. Photo 13.

Juncus maritimus with group of young *Casuarina glauca* advancing on Salicornietum at Cabbage Tree Creek, Port Hacking.

A. Musgrave, Photo. Photo 14.

Band of *Juncus maritimus* passing through Salicornietum to inner limits of Mangrove.

Photo 15.

Juncetum with old decaying trunks of *Casuarina glauca*, Cabbage Tree Creek. Port Hacking.

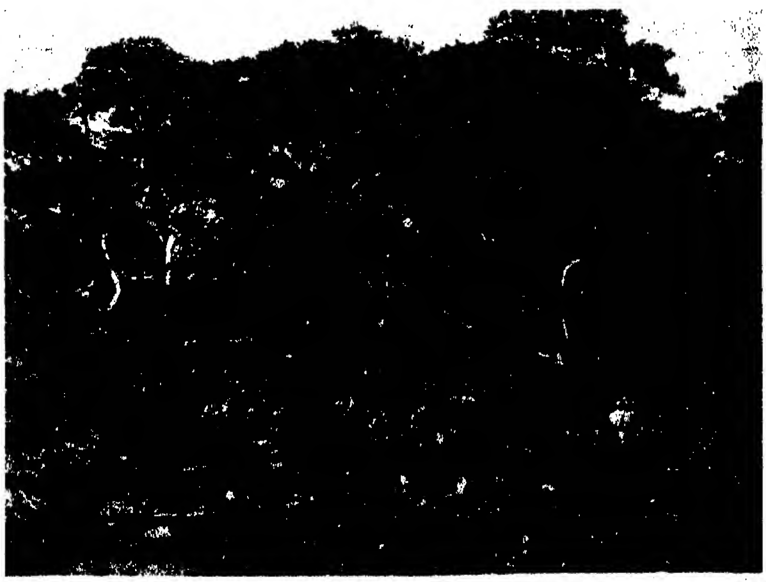
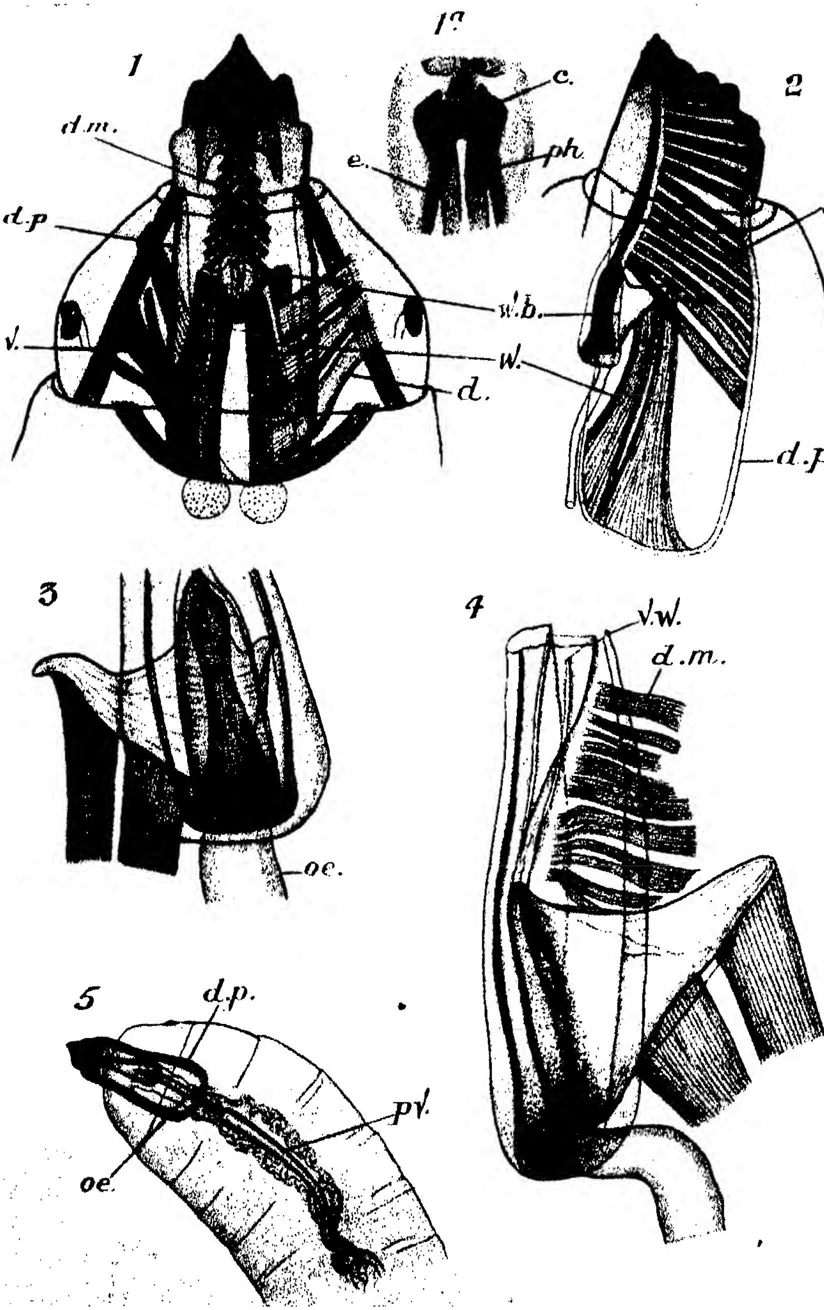


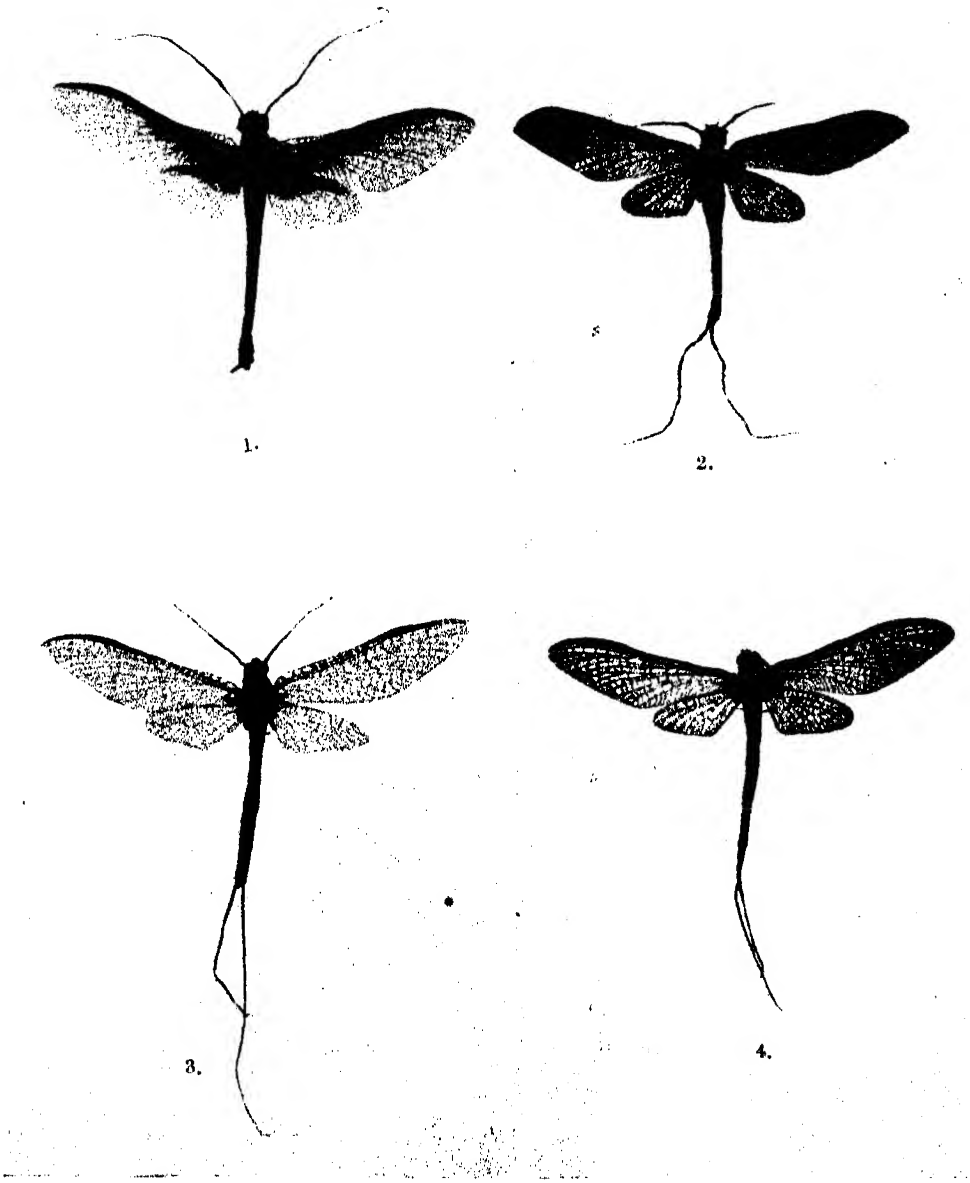
Photo 10.

Mangrove "inlier" at Cabbage Tree Creek, Port Hacking.

A. Musgrave, Photo.



Sucking apparatus of larva *Metoponia rubriceps*.



Tasmanophlebia lacustris, n.g. et sp.

1. ♂ imago; 2. ♀ imago; 3. ♂ subimago; 4. ♀ subimago.

Fig. 1. *Mitchelloneura permiana*, n.g. et sp.

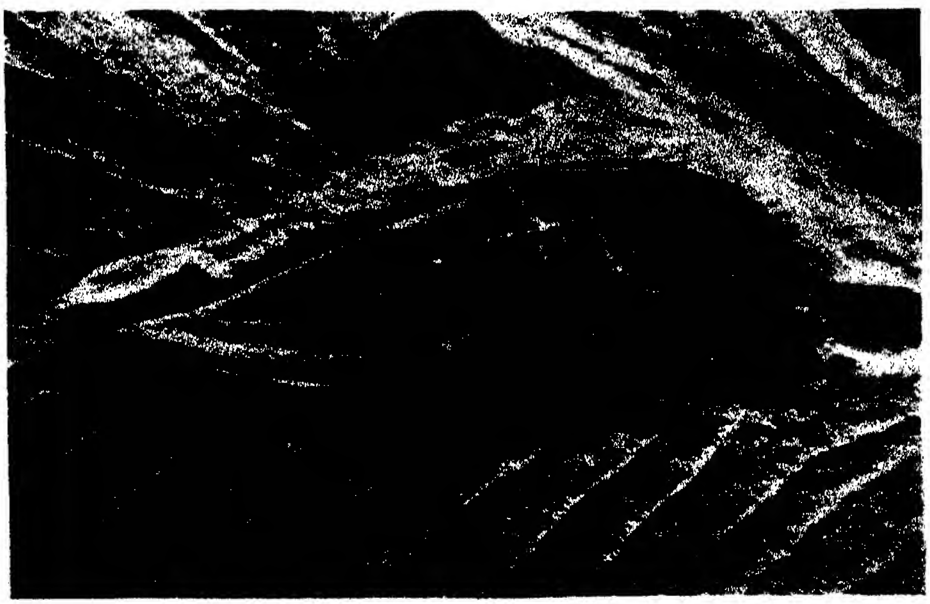
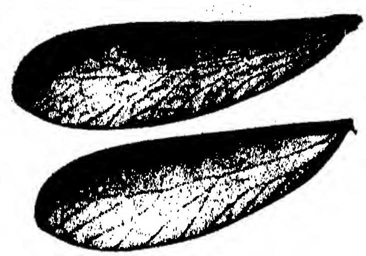


Fig. 2. *Lophioneura ustulata*, n.g et sp.



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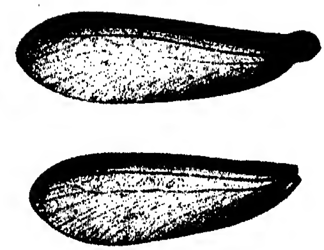

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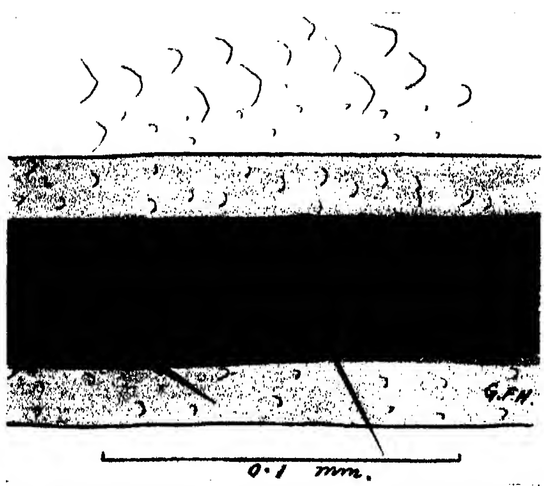

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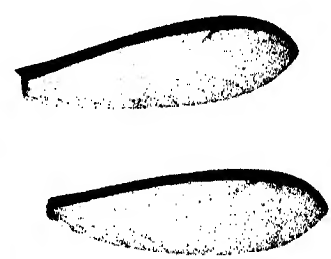
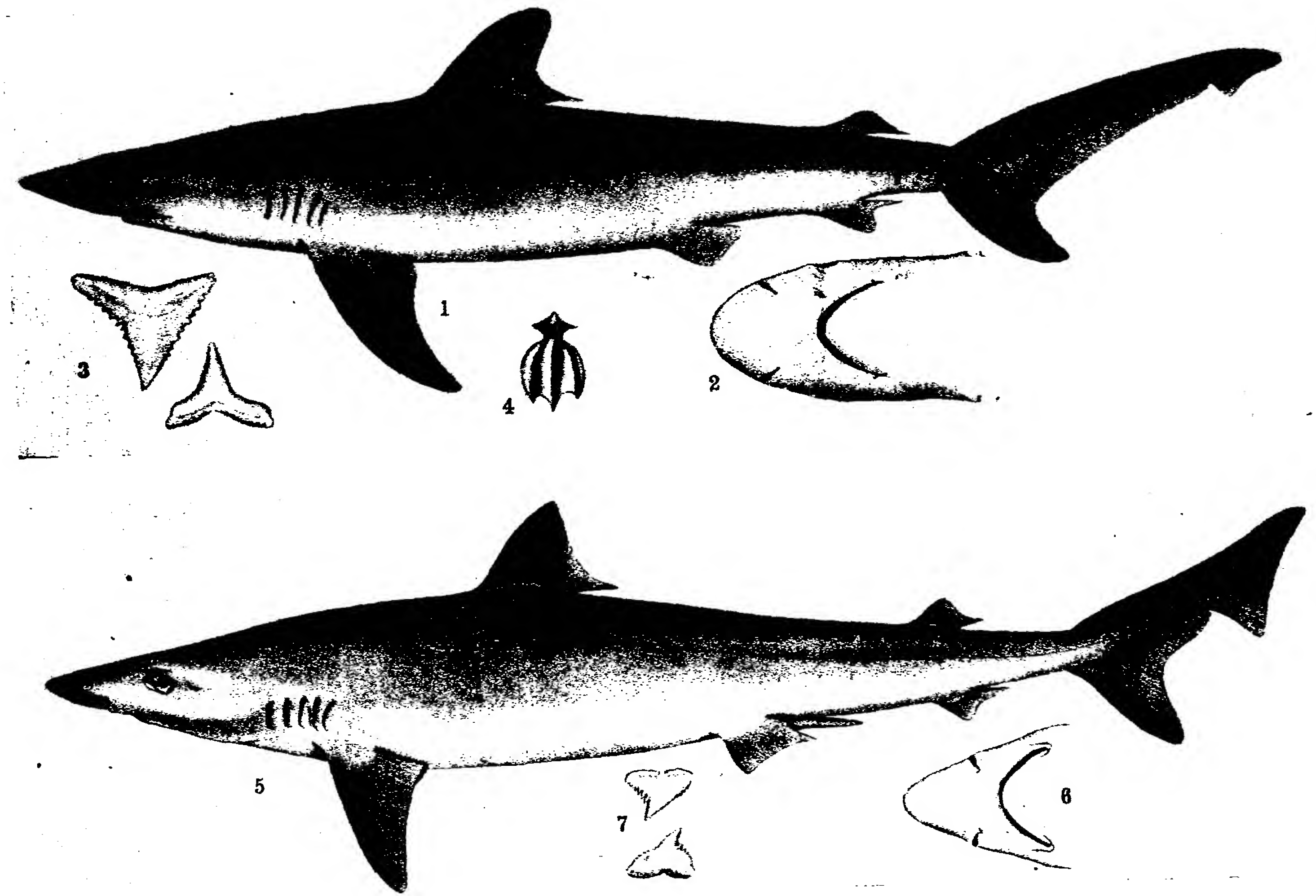


36

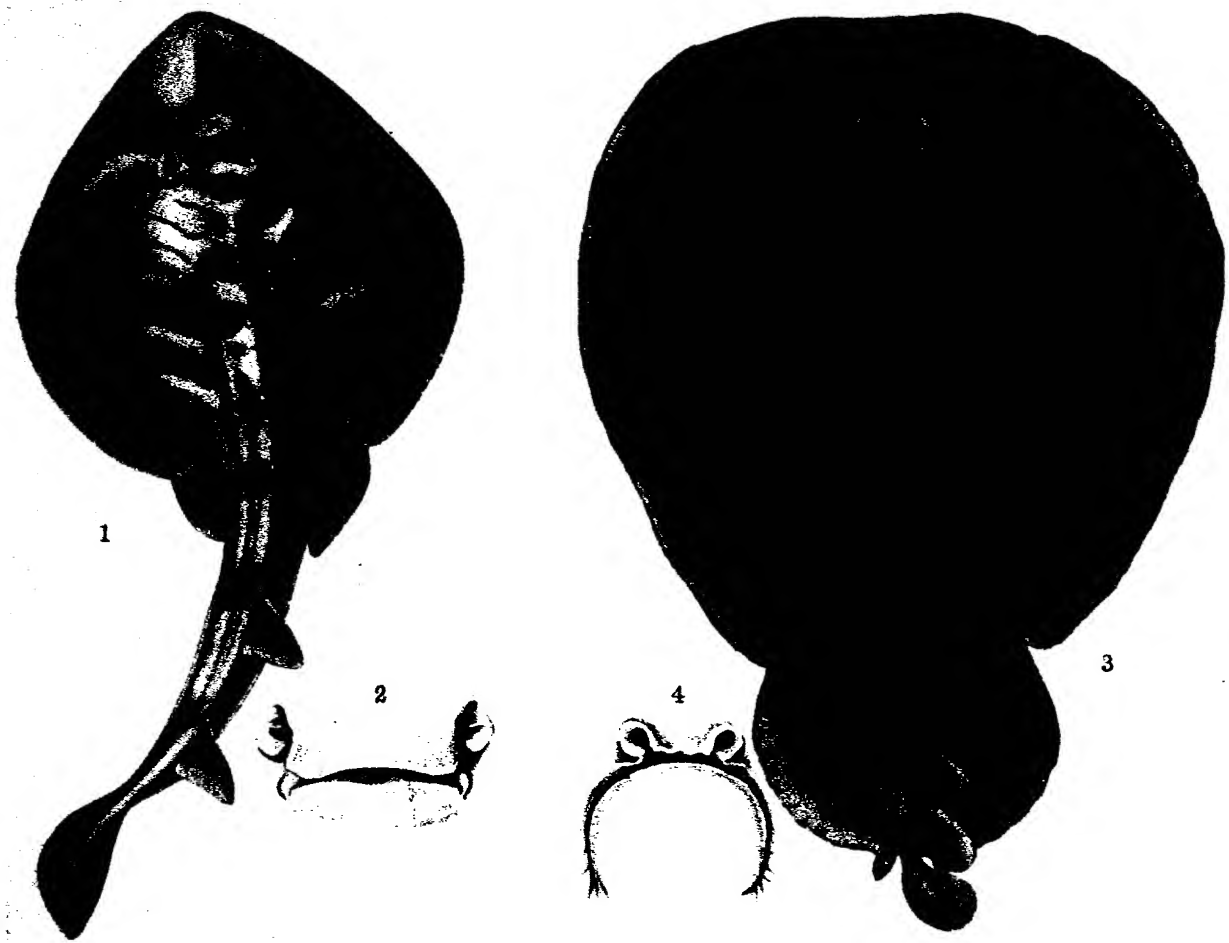
4. *Stolotermes victoriensis*, n.sp, 23-24. *Calotermes ? obscurus.*
36. *Calotermes primus*, n.sp.



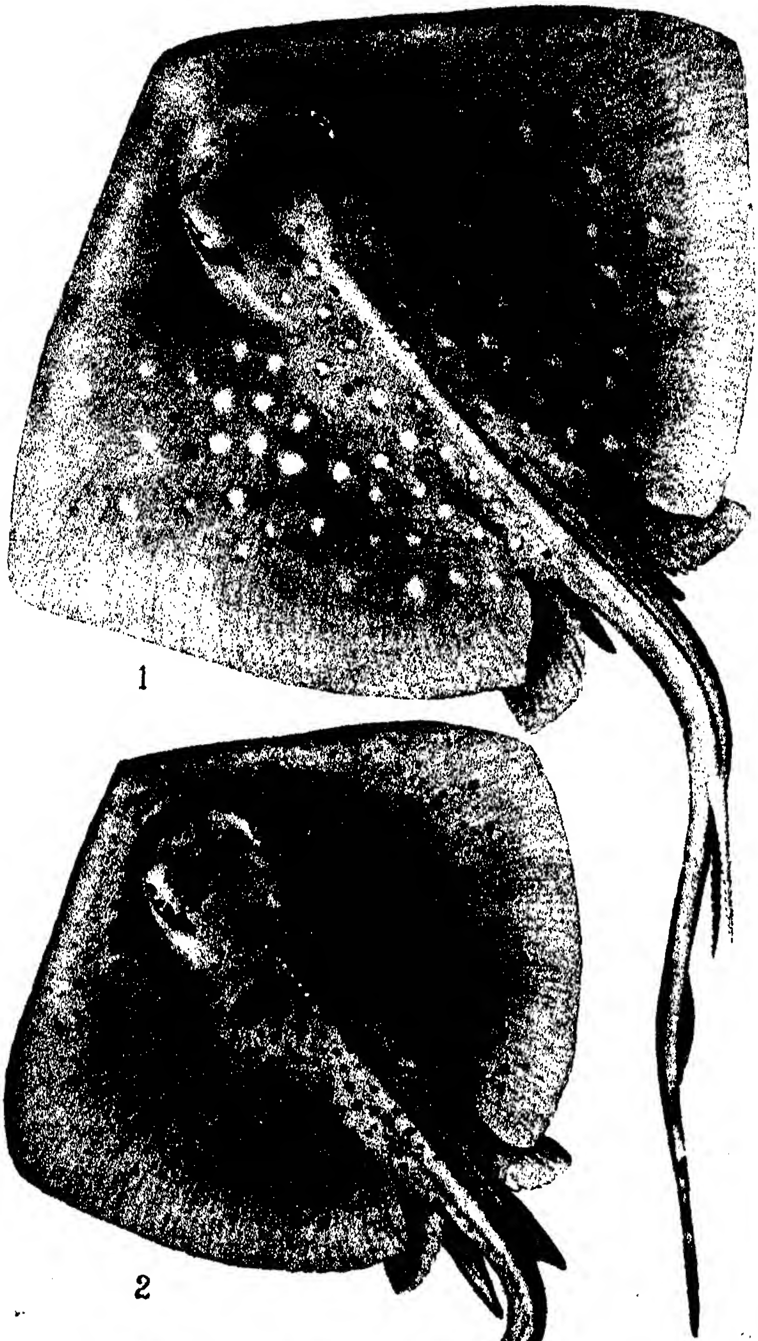
A. R. McCulloch, del.

1-4. *Carcharhinus macrurus.*

5-7. *Galeorhinus australis.*



A. R. McCulloch, del. 1-2. *Trygonorhina fasciata.* 3-4. *Hypnos subnigrum.*

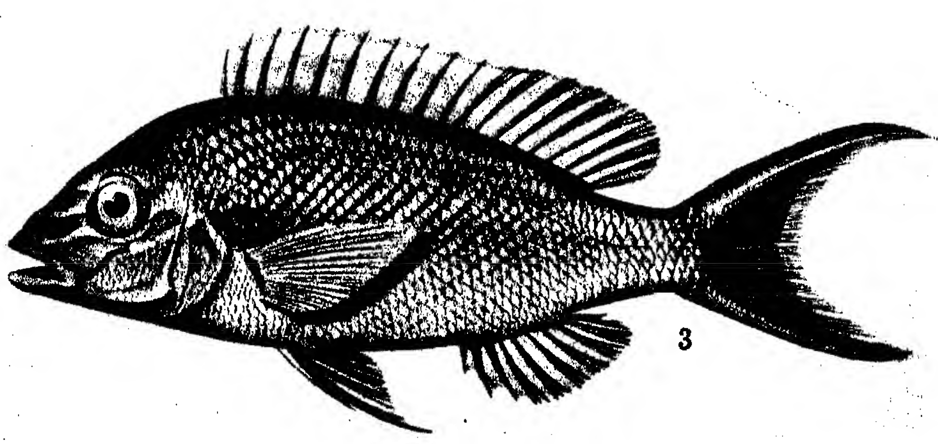


1

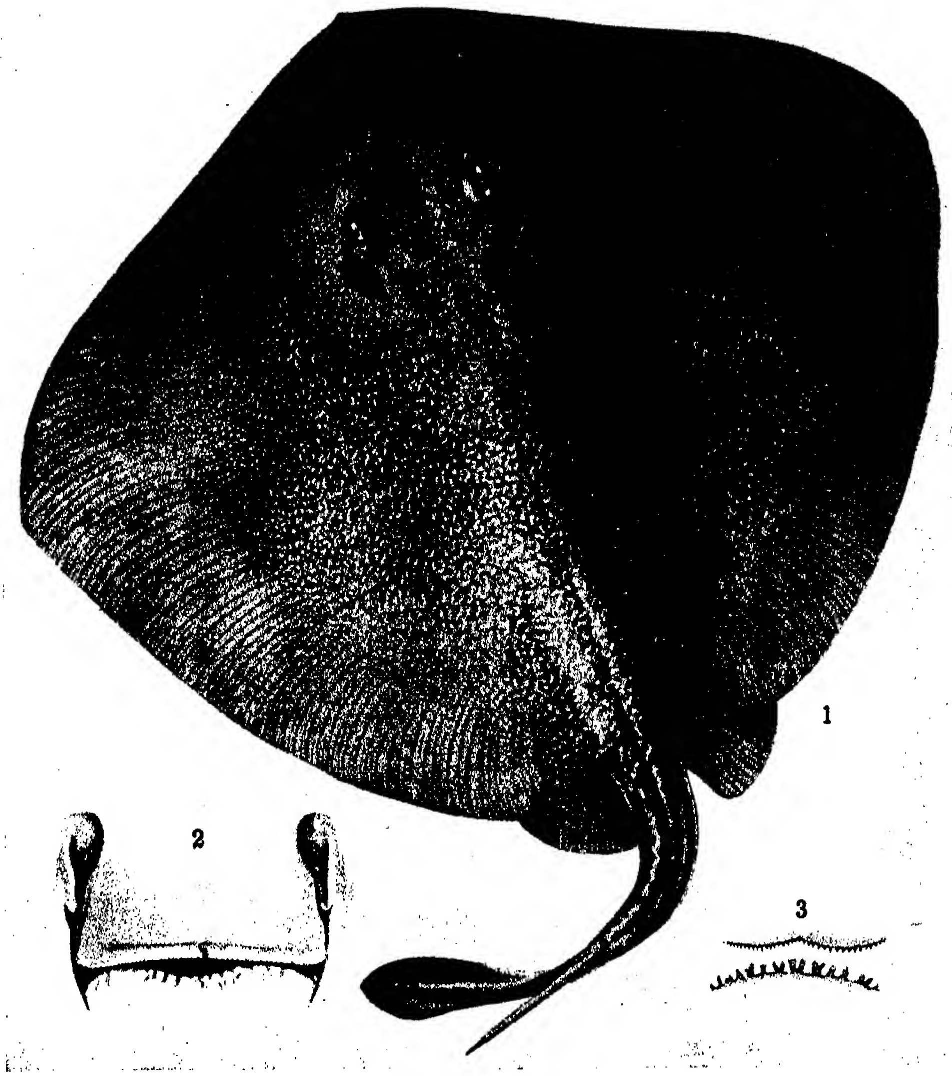
2

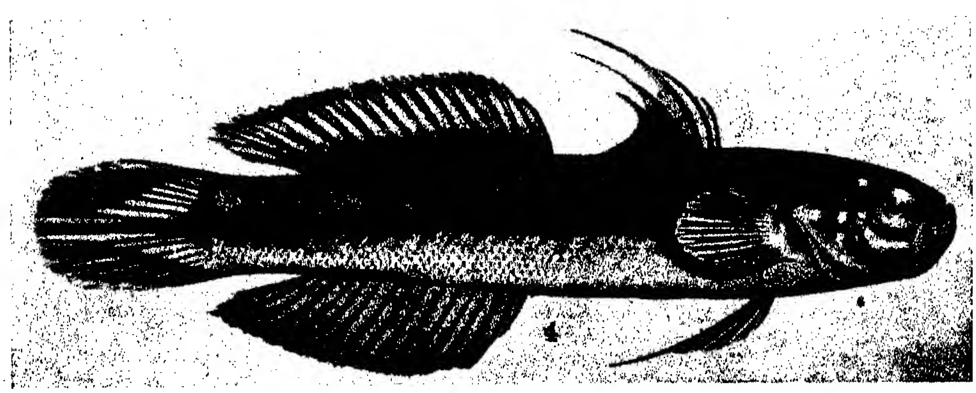
A. R. McCulloch, del. *Dasyatis kuhlii.*

Dasyatis thetidis.



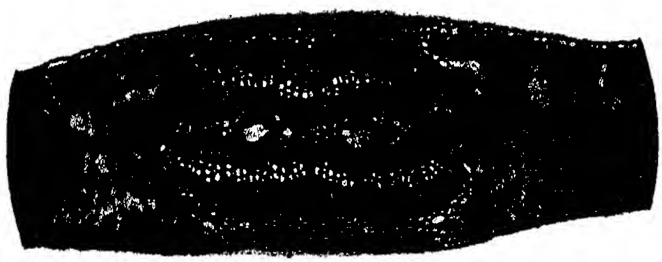
A. R. McCulloch, del. *Scolopsis temporalis*



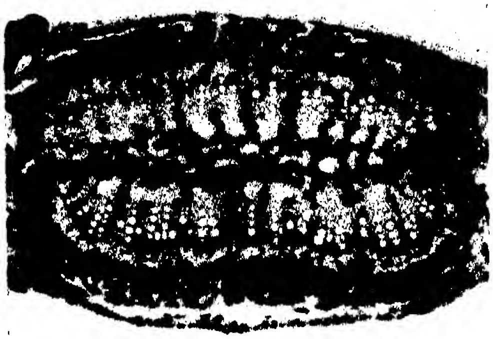


1-3. *Urolophus bucculentus*. 4. *Pariglossus rainfordi*, n.sp.

A. R. McCulloch, del.



Eucalyptus Corymbosa, Sm.



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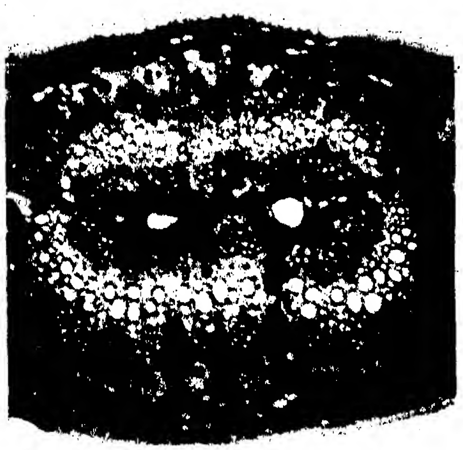

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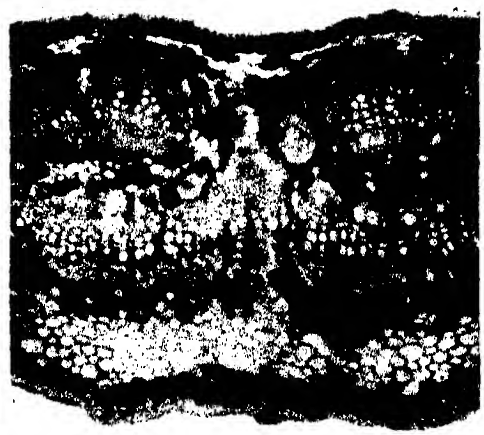

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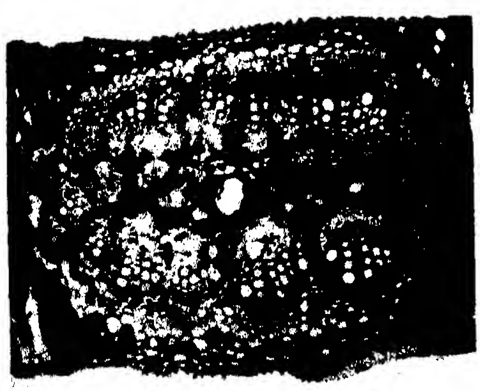

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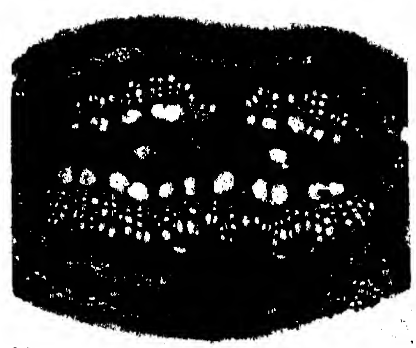
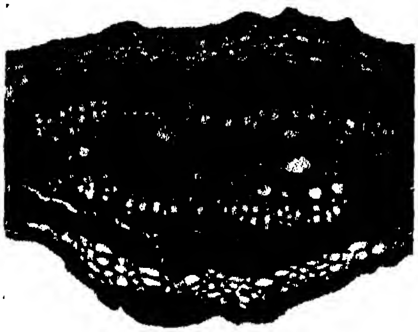


6.

1. *Eucalyptus maculata.* 2. *Angophora lanceolata.* 3. *E. citriodora.*
4. *E. calophylla.* 5. *E. terminalis.* 6. *E. Abergiana.*



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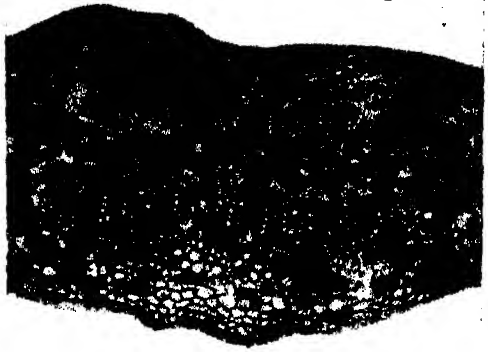

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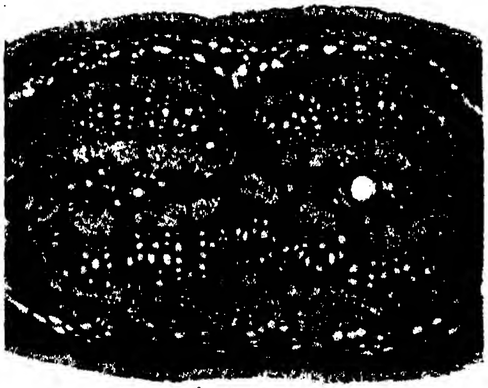

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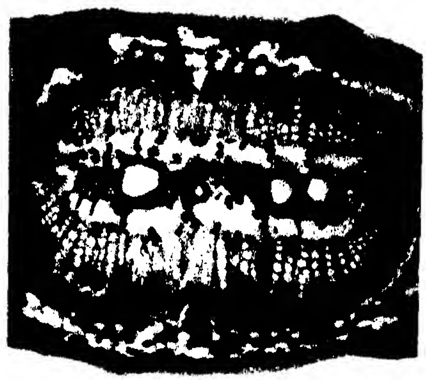

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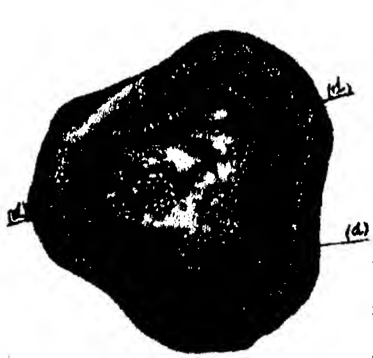
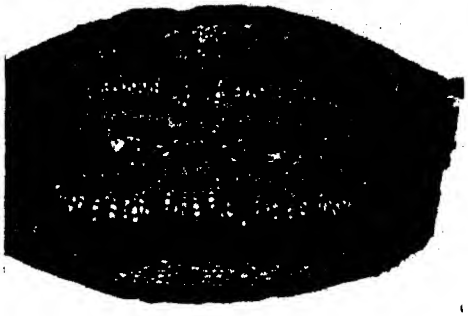


6.

1. *Eucalyptus ferruginea.* 2. *E. Watsoniana.* 3. *E. peltata*
4. *E. eximia.* 5. *E. corymbosa.* 6. *Angophora lanceolata.*

1.



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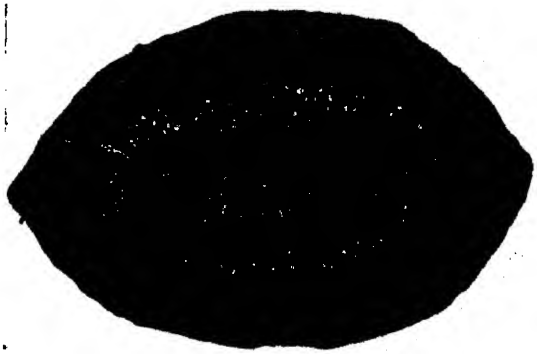

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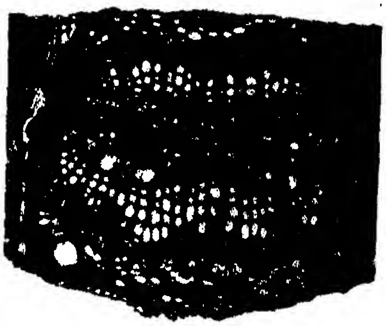

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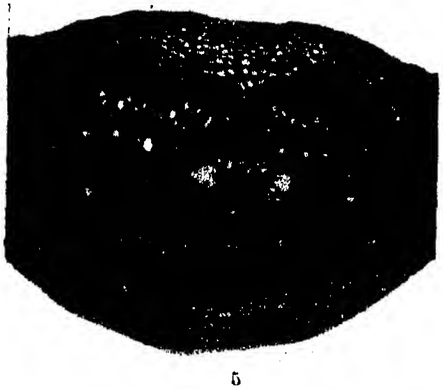

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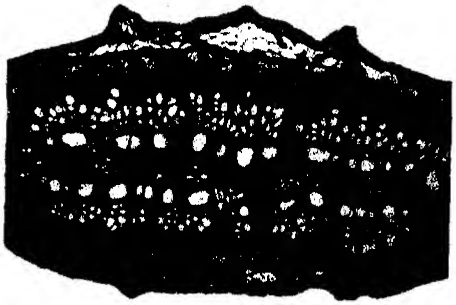
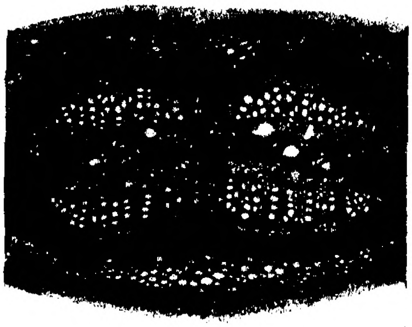


6.

1. *Eucalyptus dichromophloia.* 2, 3. *E. haematoxylon.*
4. *E. pyrophora.* 5. *E. latifolia.* 6. *E. Foelscheana.*

1.



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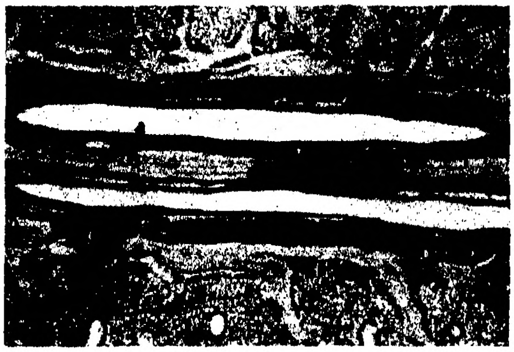

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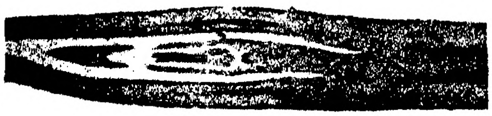

6.

7.

1, 5, 6, 7. *Eucalyptus corymbosa.* 2. *E. ficifolia.* 3. *E. trachyphloia.*
4. *E. intermedia.*